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(54) **Non-A, non-B hepatitis virus particles.**

(57) Disclosed are an isolated non-A, non-B hepatitis virus particle comprising at least one antigen selected from the group consisting of a core antigen, a matrix antigen and an envelope antigen of the non-A, non-B hepatitis virus and a method for efficiently producing the same by genetic engineering. The non-A, non-B hepatitis virus particle can advantageously be used not only for the production of an NANBV hepatitis vaccine exhibiting an extremely high immunogenicity and a diagnostic agent which is extremely high in the antibody detection ratio and in the degree of accuracy of the detection, but is also useful for researches on liver diseases, such as liver cancer.

EP 0 463 848 A2

Background of the InventionField of the Invention

5 The present invention relates to non-A, non-B hepatitis virus particles and a method for producing the same. More particularly, the present invention is concerned with non-A, non-B hepatitis virus particles which are obtained by expressing the nucleotide sequence of a region selected from the entire region of non-A, non-B hepatitis virus genome, the entire region of the ORF thereof and a region of the ORF which is obtained by cutting off NS4 and/or NS5 from the ORF, and also concerned with an effective method for producing the same. The

10 non-A, non-B hepatitis virus particles of the present invention are useful for providing a vaccine for non-A, non-B hepatitis, a diagnostic reagent for non-A, non-B hepatitis and an agent for screening blood for transfusion for preventing post-transfusion hepatitis each of which comprises the non-A, non-B hepatitis virus particles as an active ingredient, and for providing a polyclonal or monoclonal antibody which is prepared by using the non-A, non-B hepatitis virus particles. Thus, the non-A, non-B hepatitis virus particles of the present invention are use-

15 ful for producing a vaccine, an immunoglobulin, an immunological diagnostic reagent, an agent for use in affinity column chromatography for removing non-A, non-B hepatitis virus from blood for transfusion.

Discussion of Related Art20 Definition of non-A, non-B hepatitis virus:

The viral hepatitis is a liver disease caused by the infection of a hepatitis virus. Heretofore, hepatitis A virus, hepatitis B virus and hepatitis D (delta) virus have been isolated and identified. The hepatitis D virus (delta-hepatitis virus) is a deficient virus which cannot multiply by itself and requires for its multiplication the co-presence of hepatitis B virus as a helper virus. Therefore, the hepatitis D virus is present only in a patient having

25 hepatitis B. In 1974, it was reported that there were many patients having hepatitis caused by a factor other than the infection with either hepatitis A virus or hepatitis B virus. Such a hepatitis was named "non-A, non-B hepatitis", and researches on the non-A, non-B hepatitis virus have been made extensively and intensively throughout the world. Heretofore, it has been found that a plurality of types of non-A, non-B hepatitis viruses exist. Results of the researches up to now show that the non-A, non-B hepatitis virus is classified into two types

30 according to the infection route: an epidemic hepatitis virus, namely an enterically-transmitted non-A, non-B hepatitis virus, which is spread through water and food; and a blood transmitted non-A, non-B hepatitis virus which is spread through blood by transfusion, etc. Of the non-A, non-B hepatitis viruses, only an enterically-transmitted non-A, non-B hepatitis virus which spreads over the areas of Africa, India and Southeast Asia has been virologically identified, but the blood-transmitted non-A, non-B hepatitis virus has not yet been identified.

35 Hereinbelow, the blood-transmitted non-A, non-B hepatitis is often referred to simply as "NANB hepatitis", and the blood-transmitted non-A, non-B hepatitis virus is often referred to simply as "NANBV". Current situation of the studies on NANB hepatitis and problems:

With respect to the epidemiology, clinical examination, diagnosis, treatment and prevention of the NANB hepatitis, virological studies have been made in the world by the comparison of NANBV with the other hepatitis viruses, based on the knowledge of diagnostics, histopathology, immunology, molecular biology and the like

40 ["Japan Medical Journal", No. 3320, pp.3-10, 1987; "Igaku-no Ayumi (Progress of medicine)", 151(13), pp.735-923, 1989; "Kan Tan Sui (Liver, Gallbladder, Pancreas)", 21(1), pp.5-113, 1990; "Jikken Igaku (Experimental Medicine)", 8(3), pp.201-233, 1990]. With respect to the NANB hepatitis, the following findings have been reported.

45 (1) Epidemiology: In Japan, according to the estimation by the Ministry of Health and Welfare, about 60 % of chronic hepatitis patients (namely about 720 thousand patients), about 40 % of hepatocirrhosis patients (namely about 100 thousand patients) and about 40 % of liver cancer patients (namely about 7 thousand patients) are patients having NANB hepatitis. Further, the mortality attributed to the above-mentioned NANB hepatitis reaches 16 thousand per year. In U.S.A., the number of post-transfusion hepatitis patients reaches

50 150 to 300 thousand per year and 90 % of the post-transfusion hepatitis patients are patients having NANB hepatitis. Further, it is considered that 1 to 6 % of the blood donors are NANBV carriers. Further, it is estimated that in the other countries also, the incidence of NANB hepatitis and the ratio of the NANBV carrier are equal to or higher than those in U.S.A. and Japan. Therefore, prevention, early diagnosis and early treatment of the NANB hepatitis are of global importance.

55 (2) Virology: The NANBV heretofore reported comprises an envelope and assumes a viral particle having a spherical shape of about 50 nm in diameter. The taxonomic observations suggest that the known NANBV is a virus similar to a togavirus or a flavivirus, or a virus of new type different from the togavirus or flavivirus. Further, the results of pathological observations of the cytoplasm of hepatocytes of a plurality of chimpanzees

injected with serum of a patient having NANBV hepatitis show that the formation of a tubular structure occurs in the cytoplasm of a hepatocyte of some of the chimpanzees, but does not occur in the cytoplasm of a hepatocyte of the other chimpanzees, and that an intranuclear particle is formed in the cytoplasm of a hepatocyte of some of the chimpanzees. These results and the results of the epidemiological observations, tests on the presence or absence of the chloroform sensitivity and immunological diagnosis suggest that a plurality of types of NANBVs exist (see, for example, "Science", 205, 197-200, 1979, "Journal of Infectious Disease", 148, 254-265, 1983, and "Biseibutsu" (Microorganism), 5(5) 463-475, 1989). The amount of the NANBV present in the blood of a patient having NANB hepatitis is extremely small as compared to either the amount of a hepatitis A virus present in the feces of a patient having hepatitis A or the amount of a hepatitis B virus present in the blood of a patient having hepatitis B. For example, the amount of hepatitis B virus in the blood of the patient is 10^8 to 10^9 per ml in terms of Chimpanzee Infectious dose (CID), whereas the amount of NANBV in the blood of the patient is only 10^4 to 10^5 per ml in terms of CID (Bradley, D.W.: Research perspectives in post-transfusion non-A, non-B hepatitis, in "Infection, Immunity and Blood Transfusion", edited by Dodd, R.Y. & Barker, L.F., published by Alan R. Liss, Inc., New York (1985) pp.81-97). Further, it is known that except for human, there are no animals except chimpanzee that are sensitive to NANBV and that in the cytoplasm of the hepatocyte, a typical tubular structure is occasionally formed by NANBV infection. Since only chimpanzee can be used as an animal for experiment of the NANBV infection, a large number of chimpanzees are required to be used for the study of NANBV. However, the chimpanzee is not easily available and expensive. Therefore, the study of NANBV by, for example, experimental infection by NANBV, identification of NANBV and search for a useful marker for NANBV, is necessarily restricted and delayed. In order to solve these problems, various attempts have been made for the study of NANBV. For example, in an attempt, an NANBV genomic cDNA [referred to as "hepatitis C virus (HCV)"] was cloned from blood plasma of chimpanzees suffering from NANB hepatitis (Science, 244, 359-362, 1989), and it was confirmed that the antigen (referred to as "C-100") obtained by expressing the cDNA exhibited an antigen-antibody reaction with the antibody in the blood of an NANB hepatitis patient (Science, 244, 362-364, 1989). Further, in another attempt, a chimpanzee was not used and an NANBV genomic cDNA was cloned from the blood plasma of NANB hepatitis patients, and it was confirmed that the antigen obtained by expressing the cDNA exhibited an antigen-antibody reaction with the antibody in the serum of an NANB hepatitis patient (Gastroenterologia Japonica, 24, 540-544 and 545-548, 1989). Furthermore, with respect to the cloning of an NANBV genomic cDNA and the determination of the nucleotide sequence thereof and the corresponding amino acid sequence, clones provided by the following institutions are known: Mitsubishi Kasei Corp., Japan (European Patent Application Publication No. 293274), Chiron Corporation, U.S.A. (European Patent Application Publication Nos. 318216, 388232 and 398748), the Research Foundation for Microbial Diseases of Osaka University, Japan (European Patent Application Publication No. 363025 and Journal of Virology, 65, 1105-1113, 1991), Sanwa Kagaku Kenkyusho Co., Ltd., Japan (Japanese Patent Application Laid-Open Specification No. 1-186990), National Cancer Center Research Institute, Japan [Proceedings of the National Academy of Sciences (U.S.A.), 87, 9524-9528, 1990], Jichi Medical School (Japanese Journal of Experimental Medicine, 60, 167-177, 1990), National Institute of Health, Japan [Nucleic Acid Research, 17(24), 10367-10372, 1989; the same literature, 18(15), 4626, 1990; Gene, 91, 287-291, 1990; and Journal of General Virology, 71, 3027-3033, 1990), and the like. Moreover, concerning the structure of NANBV gene, it has been reported: that the total length of NANBV genome is about 10 kb; that the genome is comprised of a non-coding region at the 5'-end, an open reading frame (ORF) region and a non-coding region at the 3'-end; that in the ORF region, genes which code for a virus core antigen (protein) (C antigen), a matrix antigen (protein) (M antigen), an envelope antigen (protein) (E antigen), and six types of non-structural proteins (NS proteins) are disposed in this order from the 5'-end to the 3'-end; and that the NS protein gene is comprised of NS1, NS2, NS3, NS4a, NS4b and NS5 which are disposed in this order from the 5'-end to 3'-end. With respect to the functions of these antigens (proteins) it is believed that C antigen is responsible for the protection of the gene, E antigen is responsible for infection, M antigen is responsible for the maintenance of the structure of E antigen, NS1 serves as a complement fixing antigen, NS3 serves as a protease, NS5 serves as a polymerase and the non-coding region is responsible for the maintenance of the structure of the genome and for the replication of the genome. The functions of NS2 and NS4 have not yet been known.

(3) Clinical observations: Hepatitis is generally classified either into epidemic hepatitis and sporadic hepatitis according to the number and frequency of the occurrences of hepatitis, or into acute hepatitis, fulminant hepatitis, subacute hepatitis, persistent hepatitis and chronic hepatitis according to the severeness and stage of the hepatitis patients. The latent period of the NANB hepatitis is 2 to 26 weeks. The symptom of NANB hepatitis in the early stage is mild as compared to that of hepatitis B. For example, a patient having NANB hepatitis only becomes feverish and complains of languor. Further, 70 % of the patients have anicteric symptom. Therefore, the NANB hepatitis is frequently overlooked. However, the NANB hepatitis is very dangerous because the NANB hepatitis is likely to become chronic and, then, to progress to liver cirrhosis. Illustratively stated,

to 50 % of the patients having NANB hepatitis whose serum exhibits an increased aminotransferase activity develop chronic hepatitis. 10 to 20 % of the cases of chronic hepatitis suffer from liver cirrhosis. Further, 0.5 to 1 % of blood recipients per year becomes liver cirrhosis patients without subjective symptoms. More seriously, the liver cirrhosis may further progress to liver cancer or hepatoma. Therefore, for preventing biohazard caused by blood transfusion and bleeding, eradication of the NANB hepatitis is a matter of global importance from the viewpoint of public health.

(4) Diagnosis: As mentioned above, the NANBV (blood-transmitted type) has not yet been identified and a viral marker, such as an NANBV antigen, which is useful for the diagnosis of NANB hepatitis has not been known. Therefore, diagnosis of NANB hepatitis has been conducted by examining the titer of the antibody in serum of a patient, which is specific for each of the known pathogenic viruses, such as hepatitis A virus, hepatitis B virus, cytomegalovirus, EB virus, varicella virus and herpes simplex virus, and diagnosing the patient whose serum is negative with respect to the antibody specific for any of the above-mentioned viruses, as having NANB hepatitis, or by performing a histopathological examination through a biopsy of the liver ("Disease of the Liver and biliary system", 8th edition, S. Shenlock, pp. 326-333, 1989, Blackwell Scientific Publications). At the same time, another diagnosis method has also been used. For example, there have been used a method in which the activity of an enzyme in serum, such as GPT [glutamic-pyruvic transaminase, also known as "ALT" (alanine aminotransferase)], GOT [glutamic-oxalo-acetic transaminase, also known as "AST" (aspartate aminotransferase)], and guanine deaminase (also known as "guanase") is determined ("Kan Tan Sui (Liver, Gallbladder, Pancreas)", Vol. 14, pp. 519-522, 1987). With respect to the GPT or GOT in serum mentioned above, a standard for the diagnosis of NANB hepatitis in which lasting and abnormally high activities of GPT and GOT are utilized as a criterion for the diagnosis of NANB hepatitis, is employed in Japan ("Journal of Blood Transfusion Society in Japan", 31(4), 316-320, 1985; and "Nippon Rinsho", 46, 2635-2638, 1988). Regarding the immunological diagnosis, in the present situation in which the isolation and identification of NANBV are difficult as described above, an antigen-antibody reaction between an antigen obtained by expression of NANBV cDNA clone (which has been isolated using the techniques of genetic engineering and the knowledge of immunology) and the serum of an NANB hepatitis patient is used as a criterion. Examples of known antigens include an expression product of an NANBV cDNA prepared from the plasma of an NANB hepatitis patient (European Patent Application Publication No. 363025), an expression product of "HCV" cDNA prepared from the plasma of a chimpanzee having the symptoms of NANB hepatitis (European Patent Application Publication No. 318216 and Japanese Patent Application Laid-Open Specification No. 2-500880), an expression product of an NANBV cDNA derived from the liver of an NANBV-infected chimpanzee (European Patent Application Publication No. 293274, Japanese Patent Publication Specification No. 64-2576 and Japanese Patent Application Laid-Open Specification No. 1-124387). As a method for determining the antigen-antibody reaction, RIA (radioimmunoassay) and EIA (enzyme immunoassay) are generally used. However, these expression products are different in antigenicity. The antigen which is an expression product of HCV cDNA (that is, the C-100 antigen mentioned) can be some criterion or yardstick for the diagnosis of chronic hepatitis caused by the HCV infection. However, since the region in which the antigen (C-100) exhibits its antigenicity is limited and the detection ratio of the antibody is as disadvantageously low as about 70 % ["Biseibutsu (Microorganism)", 5, 463-475, 1989; "Kan Tan Sui (Liver, Gallbladder, Pancreas)", 20, 47-51, 1990; and "Igaku-no Ayumi (Progress of Medicine)", 151, 871, 1989], this antigen is unsatisfactory from the viewpoint of accurate diagnosis of NANB hepatitis and NANBV infection and from the viewpoint of accurate determination of the progress of a patient suffering from chronic hepatitis and acute hepatitis for treatment thereof. Therefore, it has been desired to obtain a reliable method for the diagnosis and prognosis of the NANB hepatitis.

(5) Therapy and Prevention: Recently, the usefulness of α - and β -interferons in the treatment of chronic NANB hepatitis have been reported ("Kan Tan Sui (Liver, Gallbladder, Pancreas)" vol. 20, pp. 59-64, 1990; "Igaku-no Ayumi (Progress of Medicine)", vol. 151, pp. 871-876, 1989). However, a suitable dose of α - and β -interferons and a suitable period for administration thereof have not yet been established.

On the other hand, for prevention of NANB hepatitis, various vaccines are used in which the above-mentioned conventional expression products of NANBV cDNAs (European Patent Application Publication No. 363025) or HCV cDNAs (European Patent Application Publication No. 318216) are used as an antigen. However, as is apparent from the fact that the NANBV itself has not yet been isolated and identified before completion of the present invention, it has been impossible to specify an antigen useful for NANBV vaccines from the above-mentioned expression products each having a variety of antigenic determinants (epitopes) and determine the effectiveness and safety of such a specific antigen so that the antigen can be clinically used. Accordingly, there is no NANBV vaccine which can be advantageously put into practical use.

(6) Production of NANBV particles and significance thereof: although various NANBV cDNA clones have been known as described in item (2) above, no report has been made such that an NANBV particle has been successfully produced by using the known clones. This fact means that it is extremely difficult to construct a

cDNA of about 10 kb which covers the entire region of NANBV genome, the cDNA being necessary for the production of an NANBV particle. That is, by using the prior art technique for the selection of materials to be used for the extraction of NANBV genomic RNA and the prior art technique for the extraction and the purification of the RNA, it is only possible to isolate a short RNA fragment of at most a few hundreds nucleotides and a cDNA clone thereof. When it is intended to construct a cDNA of the entire region of NANBV genome by using such a short-length cDNA fragment, it is necessary to select more than several tens of different types of cDNA fragments in a combination such that the ORFs of the cDNA fragments can form the entire region of NANBV genome, and ligate them in sequence accurately without any mistake. Needless to say, the operation for ligating cDNA fragments in sequence while satisfying such strict requirements is extremely cumbersome and difficult. It should be noted that the probability of the occurrence of a fatal mistake in the ligating operation for cDNA fragments is increased in proportion to the increase in the number of ligations. Therefore, in order to attain the accurate construction of the cDNA of the entire region of NANBV genome, it is necessary to reduce the number of ligation steps by using cDNA fragments which are as long as possible. It should further be noted that the realization of the reduction of the number of the ligations needs a high level of academic knowledge and experience and extraordinary skills with respect to the preparation by extraction of a long-length NANBV genomic RNA fragment of about 2 kb to about 5 kb and with respect to the cloning of a cDNA thereof. On the other hand, as described in item (4), since the antigen used in the commercially available diagnostic reagents for NANB hepatitis is an expression product of a part of NANBV genomic cDNA fragment and, therefore, is narrow in the antigen spectrum, the antigen reacts mainly with the serum of a chronic hepatitis patient and exhibits an antibody detection ratio as low as about unsatisfactory 70 %. Therefore, a diagnostic reagent is in a great demand which exhibits excellent specificity in the antigen-antibody reaction with the serum of not only a chronic NANB hepatitis patient but also an acute NANBV hepatitis patient and is high in the antibody detection ratio. To meet the demand, it has been earnestly desired to develop a diagnostic reagent employing, as an antigen, for example, an NANBV particles having a broad antigen spectrum and which exhibits a high detection ratio for antibody. Further, the production of NANBV particles is considered to contribute to solving the problem of item (5) so that a practically employable NANB hepatitis vaccine can be realized. From the foregoing it is apparent that the construction of a cDNA of the entire region of NANBV genome and the attainment of the mass production of NANBV particles by expressing the cDNA have been earnestly desired as a matter of global interest.

Summary Of The Invention

The present inventors have made extensive and intensive studies with a view toward solving the above-mentioned problems of the prior art by developing novel isolated NANBV particles. As a result, the present inventors have succeeded in constructing an ORF (open reading frame) region from the C antigen gene through the NS3 gene of the NANBV genomic cDNA, an entire ORF region of the NANBV genomic cDNA which is longer than the above-mentioned ORF region, and the entire region of NANBV genome comprised of the above entire ORF region and, ligated at its 5'-end and 3'-end, non-coding regions for 5'-end and 3'-end, by skillfully ligating not more than ten different NANBV cDNA clones each comprising at least 1000 nucleotides so that a desired ORF having or not having non-coding regions at 3'- and 5'ends is constructed. Moreover, the present inventors have surprisingly succeeded in the mass production of NANBV particles by introducing or inserting each of the above-mentioned regions of the NANBV genome individually into an expression vector and expressing the regions. In the present invention, the terminology "non-A, non-B hepatitis virus particle" means an expression product of the above-mentioned regions of the NANBV genome and comprises at least one antigen selected from the group consisting of a core antigen, a matrix antigen and an envelope antigen of the non-A, non-B hepatitis virus. Examples of non-A, non-B hepatitis virus (NANBV) particles include those of the following structures: a complete NANBV particle which is an NANBV antigen assembly comprised mainly of C (core) antigen, M (matrix) antigen and E (envelope) antigen and which has a nucleic acid in the virus particle; an incomplete NANBV particle which is an NANBV antigen assembly comprised mainly of C antigen, M antigen and E antigen but which has no nucleic acid in the virus particle; an NANBV core which is an NANBV antigen assembly comprised mainly of C antigen and which has a nucleic acid in the core; an incomplete NANBV core which is an NANBV antigen assembly comprised mainly of C antigen but which has no nucleic acid in the core; and an NANBV surface antigen assembly comprised mainly of E antigen. This success is attributed to a unique technique of the present inventors such that in order to obtain an authentic NANBV genome, NANBV RNAs are extracted directly from NANBV particles contained in whole blood of a patient having NANB hepatitis or a resected liver of a patient having NANB hepatitis and liver cancer in combination, without multiplying the NANBV in a chimpanzee having unknown factors which are considered to have rendered difficult the isolation of NANBV, although the amount of NANBV in the blood or resected liver is extremely small, that is as small as about 1/10,000 that of a hepatitis A virus or a hepatitis B virus, but with paying minute care in the operating procedure so that the NANBV and

its genome do not undergo cleavage and/or decomposition by the action of body fluids or blood enzymes during the storage of fresh materials for NANBV genome and that a complete NANBV genomic RNA or RNA fragments having a length of about 2 kb to 5 kb are obtained. RNAs thus prepared from fresh human materials are then converted to cDNA by means of a reverse transcriptase to obtain a cDNA library. In order to screen a NANB genomic cDNA of about 1000 to about 5000 nucleotides from the cDNA library, the cDNAs are individually inserted in lambda gt11 phage vectors and then expressed on the phage plaques at high concentration, followed by screening of NANBV genomic cDNAs by repeatedly conducting enzyme immunoassay (EIA) in which both serum from a convalescent patient having acute NANB hepatitis and serum from a patient having chronic NANB hepatitis are used. Thus, safe production of NANBV particles or NANBV antigen assemblies with high purity on a large scale at low cost without biohazard, has for the first time been realized by expressing by recombinant DNA techniques the entire region of NANBV genomic cDNA or the entire ORF region of NANBV genomic cDNA constructed by selecting cDNA clones covering the entire region or the entire ORF region of NANBV genomic cDNA, cutting-off any overlapping portion from the cDNA clones and ligating the cDNA clones in sequence such that the entire region or the entire ORF region of NANBV genomic cDNA is formed. Furthermore, it has been found that the expression product of the present invention has an extremely broad antigen spectrum as compared with a conventional expression product of NANBV genomic cDNA fragments of short length, and exhibits antigen-antibody reaction specifically with the serum of both a chronic patient and an acute patient of NANB hepatitis so that the detection ratio for the antibody is 95 % or more, solving the problem of item (6) above. That is, the expression product of the present invention has been found to make a great contribution to the prevention, diagnosis and treatment of NANB hepatitis by providing a vaccine having an enhanced immunogenicity, a diagnostic reagent exhibiting an improved detection ratio for antibody and an improvement in the preparation of antibodies. Based on the above, the present invention has been completed.

The foregoing features and advantages of the present invention will be apparent from the following detailed description and appended claims taken in connection with the accompanying drawings.

Brief Description Of The Drawings

In the Drawings:

Fig. 1(1) and Fig. 1(2) are diagrams showing the relationships between the cDNA clones of the NANBV gene to be used in the present invention, shown relative to the entire region of the NANBV genome;

Fig. 2(1) through Fig. 2(16) show the nucleotide sequence of the entire region of the NANBV genomic cDNA to be used in the present invention and the amino acid sequence coded for by the nucleotide sequence;

Fig. 3 is a diagram showing the hydrophobicity profiles of both of the NANBV of the present invention and the Japanese encephalitis virus (JEV), in which the hydrophobicity index of the NANBV is compared with that of the JEV, and wherein the abscissa indicates the amino acid number, the ordinate indicates the hydrophobicity index, the vacant triangle indicates the glycosylation site, the asterisk indicates the site of amino acid sequence (Gly-Asp-Asp) common to RNA polymerase, and C, M, E and NS represent core antigen, matrix antigen, envelope antigen and non-structural protein, respectively.

Fig. 4 is a diagram showing the steps for the construction of plasmid pMAM-neo10 for expressing the NANBV genomic cDNA in an animal cell.

Fig. 5 is a diagram showing the steps for the construction of plasmid pYHC5 for expressing the NANBV genomic cDNA in yeast.

Fig. 6 is a diagram showing the steps for the construction of plasmid pXX-49, pXX-51 and pXE-39 for the preparation of a recombinant vaccinia virus.

Fig. 7 is a graph showing the sucrose concentration and the antigenic activity of each of the fractions obtained by sucrose density-gradient centrifugation of the supernatant of the culture of recombinant vaccinia virus vXX39.

Fig. 8 is an electron microscopic photomicrograph of NANBV particles produced by culturing cells infected with recombinant vaccinia virus vXX39.

Detailed Description Of The Invention

Essentially, according to the present invention, there is provided an isolated non-A, non-B hepatitis virus particle comprising at least one antigen selected from the group consisting of a core antigen, a matrix antigen and an envelope antigen of the non-A, non-B hepatitis virus.

In a preferred embodiment of NANBV particle of the present invention, the core antigen, the matrix antigen and the envelope antigen are, respectively, coded for by a nucleotide sequence of the 333rd to 677th nucleotides, a nucleotide sequence of the 678th to 905th nucleotides and a nucleotide sequence of the 906th to

1499th nucleotides of the non-A, non-B hepatitis virus entire nucleotide sequence from the 1st to 9416th nucleotides shown in Fig. 2(1) through Fig. 2(16) hereof.

In another aspect of the present invention, there is provided a non-A, non-B hepatitis virus particle" which has a ribonucleic acid corresponding to at least part of the nucleotide sequence shown in Fig. 2(1) through Fig. 2(16) hereof.

In the present invention, unless otherwise specified, the left end and right end of the sequence of deoxyribonucleotides are the 5'-end and 3'-end, respectively. Further, unless otherwise specified, the left end and right end of the amino acid sequences of peptides are the N-terminus and C-terminus, respectively.

The isolated NANBV particle of the present invention can be prepared and identified in accordance with the following steps (I) to (IX).

Step (I): Selection and collection of a material for extracting an NANBV genomic RNA.

As a material for extracting the NANBV RNA, there may be used, for example, blood, lymph, ascites and hepatocyte of an NANBV carrier, or of a human or a chimpanzee suffering from NANB hepatitis, and hepatocyte of a patient suffering from NANB hepatitis and liver cancer or hepatoma in combination. Since the materials derived from a chimpanzee may contain NANBV in a relatively small amount as compared to the materials derived from a human and a chimpanzee has unknown factors which are considered to have rendered difficult the isolation of NANBV, the use of the materials derived from a human is preferred. Of blood, lymph, ascites and hepatocytes from a human, blood can most easily be obtained in a large amount. For example, blood which is not acceptable for use as blood for transfusion is available in a large amount from, e.g., a blood bank. Such blood can advantageously be used as a material for extracting an NANBV RNA. When blood is used as a material, blood is separated into plasma and erythrocytes. The thus obtained plasma is examined to determine whether or not the plasma is negative to the surface antigen of hepatitis B virus (WHO expert committee on viral hepatitis: Advances in viral hepatitis, WHO Technical Report Series, 602, 28-33, 1977) and negative to a genomic DNA of hepatitis B virus (Brechot, C., Hadchouel, M., Scotto, J., Degos, F., Chamay, P., Trepo, C., Tiollais, P.: Detection of hepatitis B virus DNA in liver and serum: a direct appraisal of the chronic carrier state. Lancet 2: 765-768, 1981). Further, the plasma is examined with respect to the activities of enzymes, such as GPT (Wroblewski, F. & LaDue, J. S.: Serum glutamic-pyruvic transaminase in cardiac and hepatic disease, Proc. Soc. Exp. Biol. Med., 91, 569, 1956), GOT, guanase and the like, which are employed as the criterion for the diagnosis of NANB hepatitis. The above-mentioned procedures of the separation of blood into plasma and erythrocytes and the examination of the plasma are conducted with respect to blood of different lots. The plasma which is negative to both surface antigen and genomic cDNA of hepatitis B virus and exhibits extremely high activities of the above-mentioned enzymes, for example, a GPT activity of 35 IU/ml or more, is pooled.

The number of the NANB hepatitis virus particles in blood is extremely small as compared to that of the hepatitis B virus particles as mentioned hereinbefore. From the results of the infection experiment, the number of the NANB hepatitis virus particles in blood is estimated to be about 1/10,000 of the number of the hepatitis B virus particles (Bradley, D.W., (1985): Research perspectives in post-transfusion non-A, non-B hepatitis, in "Infection, Immunity and Blood Transfusion", edited by Dodd, R.Y. & Barker, L.F., published by Alan R. Liss, Inc., New York, pp. 81-97). Therefore, for the extraction of the RNA, it is preferred to use blood in a large amount, for example, in an amount as large as about 3 to 10 liters. Fresh whole blood to be used as a material for extracting an NANB RNA from NANBV particles is stored at 1 to 5 °C in order to prevent NANBV and its gene from being denatured and to prevent its gene from being cleaved or decomposed by the action of an enzyme. It is also desirable to complete the preparation of NANBV RNAs by Step (II) within 48 to 72 hours from the collection of the fresh whole blood. When a hepatocyte is used as a material, about 1 to 3 g of a non-cancerous or a cancerous portion of a liver tissue resected from a patient having hepatoma or liver cancer which is a complication of a chronic NANB hepatitis may advantageously be used. Hepatocyte to be used as a material is stored in a frozen state at -70 °C.

Step (II): Preparation of the NANBV RNA

From the material obtained in Step (I), the RNA may be extracted and purified by conventional methods. For example, when fresh whole blood is used as the material, about 3 to 10 liters of fresh whole blood is subjected to low-speed centrifugation to collect a plasma fraction as a supernatant. The virus fraction is obtained from the plasma through purification for use in the subsequent procedure for the extraction and purification of the RNA.

On the other hand, when hepatocyte is used as a material for extracting the NANBV RNA, about 5 to 30-fold volume of a diluent containing ribonuclease inhibitor is added to the liver tissue. Then, according to the con-

ventional method using a homogenizer and the like, the liver tissue is crushed or disrupted to obtain a homogenate of hepatocyte. As a diluent, 10 to 150 mM of a conventional buffer may be used. Then, the homogenate is subjected to low-speed centrifugation to collect a supernatant. The collected supernatant is used as an original solution for the extraction and purification of the NANBV RNA. The extraction and purification of the NANBV RNA may be conducted by the conventional method, for example, an extraction method in which a mixture of a ribonuclease inhibitor, such as heparin, diethyl pyrocarbonate, and guanidine thiocyanate, with a surfactant, a chelating agent, or a reducing agent capable of enhancing the denaturation of a protein, is used; a method in which fractionation is conducted by density gradient centrifugation using sucrose, cesium chloride, cesium trichloroacetate, Ficoll (Pharmacia Fine Chemicals AB, Sweden) or the like as a solute of a gradient; a method in which separation is conducted by affinity column utilizing the 3'-terminal poly A chain which an mRNA specifically has; a separation method in which an mRNA-bonded polysome is obtained by the immunoprecipitation using an antibody specific for a protein synthesized on the polysome; a phenol extraction method based on a principle of two-phase separation; a precipitation method by the use of a polyethylene glycol, a dextran sulfate, an alcohol or the like. The above-mentioned methods may be used individually or in combination. The above-mentioned procedure for extracting and purifying the NANBV RNA may preferably be conducted at pH 3 to 10 in order to prevent the irreversible denaturation of the RNA. Thus, NANBV RNAs are obtained.

Step (III): Preparation of a double-stranded cDNA from the NANBV RNA

Using as a template each of the NANBV RNAs obtained in Step (II), a cDNA may be prepared by a standard method. That is, using an oligodeoxythymidine and a random hexanucleotide primer as primers and using a reverse transcriptase, a cDNA complementary to the NANBV RNA is synthesized using the NANBV RNA as a template to obtain a double-strand comprising the cDNA and the NANBV RNA which are complementarily bonded to each other. Then, the thus obtained double-strand is reacted with ribonuclease H so that the NANBV RNA is decomposed and removed from the cDNA. Thus, a single-stranded cDNA is obtained. Using the obtained single-stranded cDNA as a template, a double-stranded cDNA is synthesized by means of a DNA polymerase. The double-stranded cDNA synthesis may easily be conducted using a commercially available kit for cDNA synthesis, for example, cDNA Synthesis System Plus® (manufactured and sold by Amersham, England; BRL Inc., U.S.A.), cDNA System Kit® (manufactured and sold by Pharmacia LKB, Sweden), cDNA Synthesis Kit® (manufactured and sold by Boehringer Mannheim GmbH, Germany), and the like. When the quantity of the synthesized cDNA is small, the cDNA can be amplified using a conventional method, such as PCR (polymerase chain reaction) method ("PCR Technology", edited by H.A. Erlich, published by Stockton Press, 1989) using a PCR kit, such as AmpliTaq (manufactured and sold by Perkin Elmer Cetus, U.S.A.). Thus, double-stranded cDNAs are obtained.

Step (IV): Preparation of a cDNA library

Using the cDNAs prepared in Step (III), a cDNA library is prepared by a customary method. That is, the cDNAs prepared in Step (III) are individually ligated to replicable cloning vectors, to thereby obtain a cDNA library. As a replicable cloning vector, any known or commercially available vectors, such as phage, cosmid, plasmid and animal virus may be used. When a phage or a cosmid is used as a replicable vector, in order to attain high stability and high transforming ability of the vector after each of the cDNA fragments has been individually inserted therein, the *in vitro* packaging of each of the cDNA-inserted vectors is conducted by a customary method. Thus, the cDNA-inserted vectors are obtained in the form of a recombinant phage particle. The obtained phage particles are used as a cDNA library for cDNA cloning. On the other hand, when a plasmid is used as a replicable vector, the above-mentioned cDNA fragments are individually inserted in the plasmid vectors and the resultant cDNA-inserted vectors are then individually introduced into sensitive host cells, such as cells of *Escherichia coli*, *Bacillus subtilis*, yeast or the like, according to a customary method. The thus obtained transformants are used as a cDNA library for cDNA cloning. Further, when the animal virus gene is used as a replicable vector, the above-mentioned cDNA fragments are individually inserted in the virus vectors and the resultant recombinant viruses are then individually infected into sensitive animal cells according to a standard method and multiplied in the cells. In the case of the recombinant virus, the obtained recombinant viruses as such are used as a cDNA library.

The preparation of the cDNA library may easily be conducted using a commercially available kit, for example, a cDNA cloning system lambda gt10 and lambda gt11 (manufactured and sold by Amersham, England; BRL Inc., U.S.A.; and Stratagene Inc., U.S.A.), an *in vitro* packaging system (manufactured and sold by Amersham, England; BRL Inc., U.S.A.; and Stratagene Inc., U.S.A.) and the like.

Step (V): Cloning of a cDNA clone containing an NANBV gene from the cDNA library

In this step, a cDNA clone containing an NANBV gene is obtained. When the cDNA library is comprised of transformants, the transformants are cultured on a standard agar medium to form colonies. On the other hand, when the cDNA library is comprised of recombinant phage particles or recombinant viruses, these phage particles or recombinant viruses are used to infect known sensitive host cells, such as *Escherichia coli*, *Bacillus subtilis*, yeast, animal cell culture and the like, and cultured to form plaques, or to multiply the infected cells. The above-obtained transformant colonies, plaques or infected cells are subjected to immunoassay by at least one of the standard methods individually using serum from a convalescent patient having acute NANB hepatitis, serum from a patient having chronic NANB hepatitis, and serum from chimpanzee infected with an NANBV irrespective of whether or not the NANBV is of the type which causes a tubular structure to be formed in the cytoplasm of the hepatocyte of the chimpanzee, so that colonies, plaques or infected cells which have produced an NANBV antigen specifically reacted with at least one of the above-mentioned sera are selected and isolated. For the strict selection of the colonies, plaques and infected cells, it is preferred that the above procedure be repeated. From each of the thus selected and isolated colonies, plaques or the infected cells, a cDNA clone containing an NANBV gene is isolated according to a standard method described in T. Maniatis et al., *Molecular Cloning, A Laboratory Manual*, published by Cold Spring Harbor Laboratory, U.S.A., pp. 309-433 (1982). The immunoassay may be conducted by, for example, an enzyme-labeled antibody technique in which an antibody labeled with an enzyme, such as peroxidase and alkaline phosphatase is used; and a fluorescent antibody technique in which an antibody labeled with fluorescein isothiocyanate, europium or the like is used. It is preferred that the immunoassay by the above-mentioned technique be conducted by an indirect method because with the indirect method, high sensitivity immunoassay can be attained even by the use of an extremely small amount of serum from a patient. As a primary antibody to be used in the indirect method, serum from a patient having NANB hepatitis or serum from a chimpanzee having NANB hepatitis may preferably be employed because these sera contain an antibody specific for an NANBV antigen in relatively large amount. As a secondary antibody to be used in the indirect method, a commercially available anti-human Ig (immunoglobulin) antibody labeled with an enzyme, a fluorescent substance or the like may be used.

A specimen to be subjected to immunoassay may be prepared according to a conventional method, for example, a blotting method in which nucleic acids and proteins of the colonies, plaques and infected cells are adsorbed on a filter membrane, a method in which a microplate or a slide glass for microscopy is used, or the like. When the blotting method is used in combination with an indirect, enzyme-labeled antibody technique, the selection of the intended colonies, plaques or infected cells from an extremely large number of the original colonies, original plaques or original infected cells can be conducted easily and promptly. In this case, blotting is conducted by contacting a commercially available filter made of nitrocellulose, cellulose acetate, nylon or the like, with the colonies, plaques or infected cells.

The above-obtained cDNA clone is a part of the NANBV gene. Therefore, in order to obtain cDNA clones covering the entire region of the NANBV gene, it is requisite to extend the cDNA clone by a method in which cDNA fragments adjacent to the cDNA clone are isolated by using 3'- and 5'- terminals of the cDNA clone as a probe. In this case, the technique which is known as "gene walking" (also known as "genomic walking" or "chromosome walking") may be employed ("DNA cloning volume III", edited by D.M. Glover, pp.37-39, IRL Press, 1987; "Molecular Cloning - a laboratory manual" 2nd edit., T. Maniatis et al, 3.21 - 3.23, 1989). By the repetition of the cloning procedure and the gene walking, the entire region of the NANBV gene can be obtained in the form of cDNA clones.

Further, the nucleotide sequence of each of the obtained cDNA clones is determined. The determination of the nucleotide sequence of the cDNA clone may be conducted according to a conventional method, for example, the Maxam-Gilbert method, the dideoxy chain termination method (*Analytical Biochemistry*, 152, 232-238, 1986); or the like.

Based on the determined nucleotide sequence, the amino acid sequence can be deduced. The sequencing of the amino acids is conducted from the location of the initiation codon (ATG on the cDNA or AUG on the mRNA). Important portions of the amino acid sequence, for example, a hydrophilic portion, which is considered to constitute an epitope, can be identified by synthesizing a peptide corresponding to each hydrophilic portion and purifying the synthesized polypeptide by HPLC (high performance liquid chromatography), followed by subjecting the purified peptide to EIA (enzyme immunoassay) or RIA (radioimmunoassay).

The cDNA clones are preferably classified into groups according to the respective properties of the NANBV antigens coded for by the cDNA clones in order to distinguish clones from one another. In this connection, the location of each cDNA clone on the restriction map of the NANBV gene can be used as a yardstick for the classification (see Fig. 1(1) and Fig. 1(2)). Further, it has been found that some of NANBVs have the ability to cause a tubular structure to be formed in the cytoplasm of a hepatocyte of a chimpanzee, and some of NANBV do

not have such ability (Science, 205, pp. 197-200, 1979). Therefore, the cDNA clones may be identified and classified by examining the serological reactivity of each cDNA clone with serum from a chimpanzee infected with an NANBV of the type which causes a tubular structure to be formed in the cytoplasm of the hepatocyte of the chimpanzee and with serum from a chimpanzee infected with an NANBV of the type which does not cause a tubular structure to be formed in the cytoplasm of the hepatocyte of the chimpanzee. The examination of this serological reactivity may be conducted by immunoassay mentioned above.

In the present invention, as shown in Figs. 1(1) and 1(2), the cDNA clones of the NANBV gene to be used in the present invention are identified with prefix "BK".

Fig. 1(1) is a diagram showing the relationships between the cDNA clones of the NANBV gene to be used in the present invention, shown relative to the entire region of the NANBV gene, and Fig. 1(2) is a diagram showing the relationships between the cDNA clones obtained by gene walking, shown relative to the entire region of the NANBV gene.

These BK NANBV cDNA clones include, for example, Escherichia coli BK 108 (deposited at Fermentation Research Institute, Japan under the accession number FERM BP-2971), Escherichia coli BK 129 (deposited at Fermentation Research Institute, Japan under the accession number FERM BP-2972), Escherichia coli BK 138 (deposited at Fermentation Research Institute, Japan under the accession number FERM BP-2973), Escherichia coli BK 153 (deposited at Fermentation Research Institute, Japan under the accession number FERM 2974), Escherichia coli BK 157 (deposited at Fermentation Research Institute, Japan under the accession number FERM BP-3243), Escherichia coli BK 166 (deposited at Fermentation Research Institute, Japan under the accession number FERM BP-2975), and Escherichia coli BK 172 (deposited at Fermentation Research Institute, Japan under accession number FERM BP-2976). These seven BK NANBV cDNA clones are considered to cover at least the entire region of the open reading frame of the NANBV gene and probably the entire region of the NANBV gene (see Fig. 1(1) and Fig. 1(2) hereof). Further, in addition to the above-mentioned cDNA clones, the following five clones are deposited at Fermentation Research Institute, Japan as representative ones of the BK NANBV cDNA clones: Escherichia coli BK 102 (deposited at Fermentation Research Institute, Japan under the accession number FERM BP-3384), Escherichia coli BK 106 (deposited at Fermentation Research Institute, Japan under the accession number FERM BP-3385), Escherichia coli BK 112 (deposited at Fermentation Research Institute, Japan under the accession number FERM BP-3386), Escherichia coli BK 146 (deposited at Fermentation Research Institute, Japan under the accession number FERM-3387), and Escherichia coli BK 147 (deposited at Fermentation Research Institute, Japan under the accession number FERM BP-3388).

The nucleotide sequence of the entire region of the NANBV gene which is covered by the above-mentioned BK NANBV cDNA clones and the amino acid sequence which is coded for by this nucleotide sequence are shown in Fig. 2(1) through Fig. 2(16). Based on the entire NANBV nucleotide sequence and the entire NANBV amino acid sequence shown in Fig. 2(1) through Fig. 2(16), various studies and observations can be made with respect to the homology of the nucleotide sequence and amino acid sequence of the NANBV gene to those of other virus genes, the hydrophobicity index shown in Fig. 3 (hydrophobicity/hydrophilicity profile), the structure of the NANBV gene, the regions of epitopes (antigenic determinants) and the like.

With respect to the homology, studies can be made by comparison of the nucleotide sequence and amino acid sequence of the NANBV gene with those of various viruses whose genes are well known (Japanese Patent Application Laid-Open Specification No. 62-286930 and "Virology", Vol. 161, pp. 497-510, 1987) and those of other viruses, such as bovine virus diarrhea-mucosal disease virus ("Virology", Vol. 165, pp. 497-510, 1988), swine cholera virus ("Virology", Vol. 171, pp. 555-567, 1989), tobacco vein mottling virus ("Nucleic Acid Research, Vol. 165, pp. 5417-5430, 1986), etc.

With respect to the analysis of the hydrophobicity index, studies can be made by techniques using, for example, a genetic information processing software, SDC-Genetyx (manufactured and sold by SDC Software Co., Ltd., Japan), Doolittle's program (Journal of Molecular Biology, Vol. 157, pp. 105-132, 1982) and the like.

The regions of the NANBV gene coding for the various antigens (proteins) of the NANBV virus particle, that is, three structural proteins, namely, virus core antigen (protein) (C antigen), matrix antigen (protein) (M antigen) and envelope antigen (protein) (E antigen) and six non-structural proteins (NS proteins) can be determined by comparing the peptides coded for by the genes with known flavivirus with respect to the hydrophobicity index and comparing the amino acid sequences of the peptides with the peptide linking sites which are acted on by the signal peptidase derived from the host cell (Journal of Molecular Biology, 167, 391-409, 1983) and the serine protease derived from the known flavivirus (virology, 171, 637-639, 1989). With respect to the NANBV particle of the present invention, the antigens (proteins) are, respectively, coded for by the following nucleotide sequences shown in Fig. 2(1) through Fig. 2(16):

C antigen: from the 333rd to 677th nucleotides
M antigen: from the 678th to 905th nucleotides

E antigen : from the 906th to 1499th nucleotides
 NS1 protein: from the 1500th to 2519th nucleotides
 NS2 protein: from the 2520th to 3350th nucleotides
 NS3 protein: from the 3351st to 5177th nucleotides
 5 NS4a protein: from the 5178th to 5918th nucleotides
 NS4b protein: from the 5919th to 6371th nucleotides
 NS5 protein: from the 6372nd to 9362nd nucleotides

These nucleotide sequences are useful for the diagnosis of NANB hepatitis. The antigens (proteins) which are respectively coded for by these nucleotide sequences are useful as antigens for not only vaccines but also
 10 diagnostic reagents for NANB hepatitis. Furthermore, it has been found that since the NANBV particle of the present invention has various types of epitopes, a diagnostic reagent using the NANBV particle or NANBV antigen assembly of the present invention as an antigen has a broad antigen-antibody reaction spectrum and therefore can react to a wide variety of antibodies produced by infection with NANB hepatitis virus, as compared to an antigen containing a single epitope, so that it has high sensitivity in detecting NANB hepatitis, as shown in
 15 the Examples described later.

Step (VI): Expression of the entire region of the NANBV genomic cDNA and the ORF thereof and a mass production of an NANBV antigen assembly, an incomplete NANBV particle and an infective, complete
 20 NANBV particle.

In order to express the NANBV genomic cDNA cloned in Step (V) and produce an NANBV particle on a commercial scale, part or whole of the cloned cDNA present in the cDNA clone is taken out by cutting from the replicable cloning vector and recombined with a replicable expression vector. Illustratively stated, part or whole of the cDNA of each cDNA clone is taken out by cutting with a restriction enzyme to obtain an cDNA fragment
 25 containing an NANBV antigen gene (hereafter referred to as "NANBV DNA fragment"). The NANBV DNA fragments are ligated in sequence so that the entire region of the NANBV gene or the entire region of the ORF thereof is constructed and then inserted in a replicable expression vector. In order to simplify the ligating procedure for the cloned NANBV DNA fragments and prevent the occurrence of a mistake in the ligation, not greater than ten different, preferably not greater than five different NANBV DNA fragments are used for the construction
 30 of the entire region of NANBV genomic cDNA or the entire region of the ORF thereof. To realize this, NANBV DNA fragments covering the entire region of the NANBV gene or the entire region of the ORF thereof and each having a length of at least 1000 nucleotides, preferably, 1500 nucleotides, are strictly selected and any overlapping between the fragments is deleted and then the NANBV DNA fragments are ligated in sequence to thereby construct the entire region of the NANBV gene or the entire region of the ORF thereof. That is, it is
 35 necessary to provide not more than ten different cDNA clones each comprising at least 1000 nucleotides and prepared from a NANBV genomic RNA fragment of at least 1000 nucleotides. The different cDNA clones contain their respective cloned cDNA fragments which, on the whole, cover a region of at least the 333rd to 5177th nucleotides of the non-a, non-B hepatitis virus entire nucleotide sequence from the 1st to 9416th nucleotides shown in Fig. 2(1) through Fig. 2(16) hereof. The cDNA fragments are taken out from the cDNA clones by cutting
 40 so as to respectively have predetermined nucleotide sequences such that when the predetermined nucleotide sequences are arranged in sequence, the resultant nucleotide sequence would have at least a region which coincides with the region of the 333rd to 5177th nucleotides.

The above-mentioned desired region of NANBV gene can be constructed by using, for example, BK 112, BK 146, BK 147, BK 157 and BK 166 selected from the NANBV cDNA clones disclosed in Fig. 1(1) and Fig.
 45 1(2).

The taken-out cDNA fragments respectively having the above-mentioned predetermined nucleotide sequences are ligated in sequence to thereby construct a first deoxyribonucleic acid comprising a nucleotide sequence comprising at least the 333rd to 5177th nucleotides of the non-A, non-B hepatitis virus entire nucleotide sequence from 1st to 9416th nucleotides shown in Fig. 2(1) through Fig. 2(16) hereof.

As the replicable expression vector which may be used in this step, any conventionally known or commercially available expression vector can be used. Examples of expression vectors include plasmid vector pSN508 for enterobacteria (U.S. Patent No. 4,703,005), plasmid vector pBH103 for yeast, and its series (Japanese Patent Application Laid-Open Specification No. 63-22098), plasmid vector pJM105 (Japanese Patent application Laid-Open Specification No. 62-286930), vaccinia virus WR strain (ATCC VR-119) and vaccinia virus LC16m8 strain (Japanese Patent Application Publication 55-23252), an attenuated varicella virus Oka strain
 55 (U.S. Patent No. 3,985,615), an attenuated Marek's disease virus [The Journal of Japanese Society of Veterinary, 27, 20-24 (1984), and Gan Monograph on Cancer Research, 10, 91-107 (1971)], plasmid vector pTTQ series (manufactured and sold by Amersham, England), plasmid vector pSLV series (manufactured and sold

by Pharmacia LKB, Sweden), and the like.

The NANBV DNA-inserted expression plasmid vectors are individually introduced or transfected into host cells sensitive to the vector according to a conventional method, to obtain transformants which are capable of producing an NANBV particle. Then, the transformant(s) which has produced an NANBV particle is selected.

5 The production of an NANBV particle may be detected by the immunoassay mentioned in Step (V). Further, the production of an NANBV particle may be confirmed or detected according to a conventional method, such as electron microscopy, immunoelectron microscopy, density-gradient centrifugation, light scattering photometry or the like. As mentioned above, when a plasmid is used as an expression vector, a transformant having a capability of producing NANBV particles may be obtained. On the other hand, when an animal virus gene is used as an expression vector, a recombinant virus which is capable of producing an NANBV particle is obtained.

10 By culturing the transformant or recombinant virus obtained above according to a customary method, an NANBV particle can be produced in the culture of the transformant or recombinant virus on a commercial scale. With respect to the details of the method in which an animal virus gene is used as an expression vector, reference may be made to European patent Application Publication No. 0 334 530 A1.

15 Accordingly, in still another aspect of the present invention, there is provided a method for producing an isolated non-A, non-B hepatitis virus particle, which comprises:

(a) providing not more than ten different cDNA clones each comprising at least 1000 nucleotides and prepared from a non-A, non-B hepatitis virus genomic RNA fragment of at least 1000 nucleotides, said not more than ten different cDNA clones containing their respective cloned cDNA fragments which, on the whole, cover a region of at least the 333rd to 5177th nucleotides of the non-A, non-B hepatitis virus entire nucleotide sequence from the 1st to 9416th nucleotides shown in Fig. 2(1) through Fig. 2(16) hereof;

20 (b) taking out said cDNA fragments from said cDNA clones by cutting so as to respectively have predetermined nucleotide sequences such that when the predetermined nucleotide sequences are arranged in sequence, the resultant nucleotide sequence has at least a region which coincides with the region of the 333rd to 5177th nucleotides;

25 (c) ligating said taken-out cDNA fragments respectively having said predetermined nucleotide sequences in sequence to thereby construct a first deoxyribonucleic acid comprising a nucleotide sequence comprising at least the 333rd to 5177th nucleotides of the non-A, non-B hepatitis virus entire nucleotide sequence from the 1st to 9416th nucleotides shown in Fig. 2(1) through Fig. 2(16) hereof;

30 (d) introducing at least one deoxyribonucleic acid selected from said first deoxyribonucleic acid and a second deoxyribonucleic acid obtained by substituting at least one nucleotide of the nucleotide sequence of said first deoxyribonucleic acid in accordance with the degeneracy of the genetic code into a replicable expression vector selected from a plasmid and an animal virus gene to obtain a replicable recombinant DNA comprising said plasmid and said at least one deoxyribonucleic acid introduced therein when said replicable expression vector is a plasmid or obtain a recombinant virus comprising said animal virus and said at least one deoxyribonucleic acid introduced therein when said replicable expression vector is an animal virus gene;

35 (e) transfecting prokaryotic or eukaryotic cells with said recombinant DNA when said replicable expression vector used in step (d) is a plasmid, to thereby form a transformant, followed by selection of said transformant from parent cells of the prokaryotic or eukaryotic cell culture;

40 (f) culturing said transformant obtained in step (e) in prokaryotic or eukaryotic cells to thereby produce a non-A, non-B hepatitis virus particle, or culturing said recombinant virus obtained in step (d) in eukaryotic cells to thereby produce a non-A, non-B hepatitis virus particle together with an animal virus; and

(g) isolating said non-A, non-B hepatitis virus particle.

45 In the above method, the deoxyribonucleic acid may preferably comprise a nucleotide sequence of the 333rd to 5918th nucleotides, a nucleotide sequence of the 333rd to 6371st nucleotides, a nucleotide sequence of the 333rd to 9362nd nucleotides, or a nucleotide sequence of the 1st to 9416th nucleotides.

50 It should be noted that in order to produce the NANBV particle of the present invention, the region of the NANBV cDNA to be expressed is required to contain all of the nucleotide sequences respectively coding for NS1 protein, NS2 protein and NS3 protein of NANBV in addition to all of the nucleotide sequences respectively coding for core antigen, matrix antigen and envelope antigen of NANBV.

Step (VII): Purification of an NANBV particle

55 The NANBV particle produced in the culture of the transformant or recombinant virus may be purified using an appropriate combination of customary techniques, for example, salting-out; adsorption and desorption using a silica gel, an activated carbon or the like; precipitation by an organic solvent; fractionation by ultracentrifugation; separation by ion exchange chromatography or affinity column chromatography; fractionation by high-

performance liquid chromatography or electrophoresis, and the like.

When the NANBV particle is purified from the culture of an *E. coli* transformant or a yeast transformant, from the viewpoint of effective removal of allergens derived from *E. coli* and yeast which cause the quality of the produced NANBV particle to be markedly lowered, it is preferred that the purification be conducted by, for example, the steps of (1) adsorption and elution using a silica gel, removal of impurities by adsorption on an activated carbon and (2) fractionation by density gradient centrifugation in this order (Japanese Patent Application Laid-Open Specification No. 63-297). When the NANBV particle is purified from the culture of a recombinant virus, e.g., the culture of a recombinant virus-infected cells, a high purity NANBV particle can be obtained by subjecting a crude solution containing the particle to purification by ultracentrifugation and density gradient centrifugation repeatedly. Furthermore, for inactivating the NANBV particle in the culture to secure the safe handling of the particle and for fixing the particle to stabilize the immunogenicity and the antigenicity of the particle, it is preferred to add a conventional inactivating agent to the culture of the transformant or recombinant virus-infected cells, or to a culture liquid obtained by removing the transformant cells or the recombinant virus-infected cells. For example, an inactivating agent, such as formalin, may be added in an amount of from 0.0001 to 0.001 (v/v)% in the final concentration, followed by incubation at 4 to 37°C for 5 to 90 days to thereby inactivate the NANBV particle. It should be noted that when an attenuated virus is used as an expression vector, an NANBV particle obtained from the recombinant virus can be used as an active ingredient for a live attenuated vaccine without the step of inactivation. The thus obtained NANBV particle suspension which is highly purified can be used for the preparation of a vaccine and a diagnostic reagent, as an original NANBV particle solution (an original NANBV vaccine solution).

In a further aspect of the present invention, there is provided a recombinant comprising a replicable expression vector selected from a plasmid and an animal virus gene and a deoxyribonucleic acid comprising at least one nucleotide sequence selected from the group consisting of a first nucleotide sequence of the 333rd to 5177th nucleotides of the non-A, non-B hepatitis virus entire nucleotide sequence from the 1st to 9416th nucleotides shown in Fig. 2(1) through Fig. 2(16) hereof and a second nucleotide sequence obtained by substituting at least one nucleotide of said first nucleotide sequence in accordance with the degeneracy of the genetic code.

In the above-mentioned recombinant, the first nucleotide sequence may preferably comprise a nucleotide sequence of the 333rd to 5918th nucleotides, a nucleotide sequence of the 333rd to 6371st nucleotides, a nucleotide sequence of the 333rd to 9362nd nucleotides, or a nucleotide sequence of the 1st to 9416th nucleotides.

The replicable recombinant can be used not only for producing the NANBV particle of the present invention but also for amplifying the NANBV genomic cDNA to be used in the present invention by replication.

The purified NANBV particle of the present invention is useful as a diagnostic reagent for detecting NANB hepatitis.

The NANBV particle of the present invention can be formulated into a diagnostic reagent as follows. The purified NANBV particle solution obtained in Step (VII) mentioned above is dispensed in a vessel, such as a vial and an ampul, and sealed. The NANBV particle solution put in a vessel may be lyophilized before the sealing, in the same manner as mentioned above. The amount of the NANBV particle put in a vessel is generally about 1 µg to about 10 mg. Alternatively, the NANBV particle may also be adsorbed on the surface of a customarily employed support, such as a microplate, polystyrene beads, filter paper or a membrane.

The determination of the reactivity of the serum with the NANBV particle may be conducted in substantially the same manner as described in Step (V) mentioned above. That is, the determination of the reactivity may be conducted by a conventional immunoassay method, such as radioimmunoassay (RIA), enzyme-linked immunosorbent assay (ELISA), fluorescent antibody technique (FA), passive haemagglutination (PHA), reversed passive haemagglutination (rPHA) and the like. The amount of the NANBV particle to be used for the above immunoassay is generally from about 0.1 to about 100 mg/ml of serum. Particularly, the amounts of the NANBV particle to be used for RIA, ELISA, FA, PHA and rPHA are generally from 0.1 to 1 mg/ml, from 0.1 to 1 mg/ml, from 1 to 100 mg/ml, from 1 to 50 mg/ml and from 1 to 50 mg/ml, respectively.

The NANBV particle of the present invention may also be used for screening blood for transfusion. The screening method consists in:

- a) isolating serum from whole blood;
- b) contacting serum of an unknown blood with an isolated NANBV particle;
- c) determining whether the serum reacts with the NANBV particle;
- d) classifying the serum as positive or negative to non-A, non-B hepatitis based on the reactivity; and
- e) effecting separation of the blood in accordance with the identification.

The contact of serum of an unknown blood with the NANBV particle of the present invention, and the determination of the reactivity of the serum of the blood with the NANBV particle may be conducted in the same manner as mentioned above with respect to the method for diagnosing NANB hepatitis. By the above method,

a blood for transfusion free from the NANBV can be selected.

The polyclonal antibody and monoclonal antibody specific for the NANBV particle of the present invention may be used as an agent for removing NANBV from blood for transfusion. That is, NANBV present in blood can efficiently be removed by the polyclonal antibody or the monoclonal antibody by antigen-antibody reaction.

Further, the NANBV particle of the present invention may advantageously be used as an active ingredient of a vaccine for NANB hepatitis. The vaccine for NANB hepatitis may be prepared as follows. The culturing of a transformant containing a recombinant phage or plasmid carrying the cDNA coding for the NANBV particle, or a cell infected with the recombinant virus carrying the cDNA coding for the NANBV particle is conducted in the same manner as described above to thereby produce the NANBV particle in the culture. For inactivating the NANBV particle in the culture to secure the safety of the NANBV particle and for fixing the NANBV particle to stabilize the immunogenicity and the antigenicity of the particle, it is preferred to add a conventional inactivating agent to the culture of the transformant or recombinant virus-infected cell, or to a culture medium obtained by removing the transformant cells or the recombinant virus-infected cell. For example, an inactivating agent, such as formalin, may be added in an amount of from 0.0001 to 0.001 v/v%, followed by incubation at 4 to 37 °C for 5 to 90 days. Then, the resultant culture or culture medium is subjected to purification in the same manner as mentioned above. Thus, an original NANB hepatitis vaccine solution containing the purified NANBV particle is obtained.

The original NANBV hepatitis vaccine solution is filtered using a microfilter by a standard method to sterilize the solution. The filtrate is diluted with physiological saline so that the protein concentration is about 1 to about 500 µg/ml as measured by the Lowry method. Further, at least one stabilizing agent may be added. As the stabilizing agent, any commercially available stabilizing agent may be used. Examples of stabilizing agents include gelatin and hydrolysates thereof, human albumin, saccharides such as glucose, fructose, galactose, sucrose and lactose, and amino acids such as glycine, alanine, lysine, arginine and glutamine. Also, an adjuvant may be used to prepare an adsorbed vaccine. In this case, an adjuvant, such as, an aluminum hydroxide gel is added to the solution, before the addition of a stabilizing agent, so that the concentration of the added gel becomes about 0.1 to about 1.0 mg/ml, followed by mixing, thereby adsorbing the NANBV particle onto the adjuvant. As an adjuvant, there may also be employed precipitating depositary adjuvants such as calcium phosphate gel, aluminum phosphate gel, aluminum sulfate, alumina and bentonite, and adjuvants which are capable of inducing antibody production such as muramyl peptide derivatives, polynucleotides, Krestin® (manufactured and sold by Kureha Chemical Industry Co., Ltd., Japan) and picibanil (both of which are an antineoplastic agent).

Then, the thus obtained NANB hepatitis vaccine solution containing an (gel-adsorbed or non-adsorbed) NANBV particle is dispensed into a small vessel, such as an ampul and a vial, and sealed. Thus, there is obtained a purified (adsorbed or non-adsorbed) NANB hepatitis vaccine comprising an (adsorbed or non-adsorbed) NANBV particle.

The NANB hepatitis vaccine solution thus obtained may be lyophilized to obtain the NANB hepatitis vaccine in a dried form so that the product can be transported to and stored at a place of severe climate, for example, in an area in the tropics. The lyophilization may generally be conducted according to a standard method after the liquid (adsorbed or non adsorbed) NANB hepatitis vaccine is dispensed in a vessel such as a vial and an ampul. After lyophilization, a nitrogen gas is introduced in the vessel containing the dried vaccine, followed by sealing. Incidentally, the quality of the vaccine produced is examined in accordance with "Adsorbed Hepatitis B Vaccine", "Dried Japanese Encephalitis Vaccine", and "Adsorbed Pertussis Vaccine" provided for in Notification No. 159 of the Ministry of Health and Welfare, Japan, "Minimum Requirements for Biological Products".

The NANB hepatitis vaccine may be prepared in the form of a mixed vaccine which contains an adsorbed NANBV particle mentioned above and at least one antigen other than the present NANBV particle. As the antigen other than the present NANBV particle, there may be employed any antigens that are conventionally used as active ingredients of the corresponding vaccines insofar as the side effects and adverse reactions caused by such other antigens and the NANBV particle are not additively or synergistically increased by the use of the NANBV particle and such other antigens in combination and the antigenicities and immunogenicities of the NANBV particle and such other antigens are not reduced by the interference between the NANBV particle and other antigens. The number and the types of the antigens which may be mixed with the NANBV particle are not limited insofar as the side effects and adverse reactions are not increased additively or synergistically and the antigenicity and immunogenicity of each of the NANBV particle and such antigens are not reduced as mentioned above. Generally, two to six types of antigens may be mixed with the NANBV particle. Examples of antigens which may be mixed with the present NANBV particle, include detoxified antigens, inactivated antigens or toxoids which are derived from Japanese encephalitis virus, HFRS (hemorrhagic fever with renal syndrome) virus, influenza virus, parainfluenza virus, hepatitis B virus, dengue fever virus, AIDS virus, Bordetella pertussis, diphtheria bacillus, tetanus bacillus, meningococcus, pneumococcus and the like.

Generally, the vaccine comprising the NANBV particle of the present invention may be contained and sea-

led in a vial, an ampul or the like. The vaccine of the present invention may generally be administered in the form of a liquid or suspension. In the case where the vaccine is in a dried form, the vaccine is dissolved or suspended in sterilized distilled water before administration, the amount of the distilled water being such that the volume becomes the original volume before being subjected to lyophilization. Generally, the vaccine may be administered subcutaneously. The dose of the vaccine may generally be about 0.5 ml. In general, the dose of the vaccine for a child may be half as much as that of the vaccine per adult. The vaccine may generally be administered twice at an interval of about one week to one month and then, about half a year later, administered once more.

Further, the NANBV particle may be used for preparing an antibody, such as a polyclonal antibody and a monoclonal antibody, specific for the NANBV particle. For example, a polyclonal antibody specific for the NANBV particle may be prepared by a conventional method as follows. The purified NANBV particle of the present invention is inoculated subcutaneously, intramuscularly, intraperitoneally or intravenously to an animal, such as mouse, guinea pig and rabbit. The inoculation of the NANBV particle is generally conducted several times at intervals of 1 to 4 weeks, to thereby completely immunize the animal. In order to enhance the immunizing effect, a conventional and commercially available adjuvant may be used. Then, blood serum is collected from the immunized animal and an anti-NANBV particle polyclonal antibody is isolated and purified from the blood serum according to a standard method.

On the other hand, a monoclonal antibody specific for the NANBV particle may be prepared by a conventional method as described, for example, in Cell Technology, 1, 23-29 (1982). For example, splenic cells obtained from a mouse immunized with the purified NANBV particle are fused with commercially available mouse myeloma cells by cell fusion technique, to obtain hybridomas. The hybridomas are screened to obtain a hybridoma capable of producing an antibody reactive with the NANBV particle. The obtained hybridoma is cultured in a standard method. From the supernatant of the culture, an anti-NANBV particle monoclonal antibody is isolated and purified by a standard method.

The above-mentioned polyclonal antibody and monoclonal antibody may also be used as a diagnostic reagent for diagnosing NANB hepatitis. The diagnosis of NANB hepatitis using the antibody may be conducted by immunoassay in substantially the same manner as mentioned above with respect to the diagnosis of NANB hepatitis using the NANBV particle. By the use of the polyclonal antibody or the monoclonal antibody, the identification and quantification of the NANBV particle present in a liver tissue and blood can be conducted.

The NANBV particle of the present invention has an extremely broad spectrum of antigenicity and specifically reacts with the serum not only of a chronic NANBV patient but also of an acute NANBV patient. Therefore, the NANBV particle is able to provide a diagnostic reagent of high reliability having not only a high detection ratio for an antibody but also a high precision in the detection. Further, when the NANBV particle of the present invention is used for screening blood for transfusion, blood which is infected by NANBV can be selected easily with high reliability and removed from blood not infected by NANBV. Therefore, the post-transfusion NANB hepatitis can be prevented.

Further, the NANBV particle of the present invention may advantageously be used as an active ingredient of a vaccine for preventing NANB hepatitis, which is extremely excellent in immunogenicity. In addition, a recombinant virus, e.g., recombinant vaccinia virus prepared by inserting the NANBV genomic cDNA into a vaccinia virus, is useful as an active ingredient of a vaccine.

Further, by the use of the NANBV particle of the present invention, an antibody, particularly monoclonal antibody, specific for NANBV can easily be prepared. The antibody specific for NANBV can advantageously be used as not only a diagnostic reagent for detecting NANB hepatitis, but also an agent for removing NANBV from blood for transfusion.

Furthermore, it should be noted that the NANBV particle of the present invention is not produced by the infection of an animal with a virus, but produced in an isolated form by gene expression of the DNA coding for the present NANBV particle in a host cell. Hence, the possibility of infection during the steps for production of the present NANBV particle is substantially eliminated. Also, the production cost can be decreased. Moreover, since all of the materials used in the production process, e.g., medium for the incubation system, are well-known in respect of the composition thereof, purification is facile and an NANBV particle product having high purity can be obtained.

By the present invention, it is possible to produce an isolated NANBV particle and its gene with high purity which cannot be found in nature. The produced NANBV particle and its gene can greatly contribute to researches on NANB hepatitis, hepatoma, liver cancer, etc.

The present invention will now be described in detail with reference to the following Examples and Reference Examples, which should not be construed to be limiting the scope of the present invention. Example 1 is divided into Part I and Part II, and Reference Examples 1-3 are inserted therebetween.

Example 1 (Part I)

Step 1 (Preparation of a plasma-derived RNA for producing a cDNA, which is complementary to NANBV genome RNA)

5 In order to obtain NANBV from plasma, 4.8 liters of human plasma exhibiting a glutamic-pyruvic transaminase (GPT) activity of 35 IU/liter or more (as measured by the method of Wroblewski, F & J.S. LaDue: Serum glutamic-pyruvic transaminase in cardiac and hepatic disease. Proc. Soc. Exp. Biol. Med., 91:569, 1956) was applied on a 30 % (w/w) aqueous sucrose solution, and subjected to centrifugation at 48,000 x g at 4 °C and
10 for 13 hours to obtain a precipitate. The precipitate was suspended in an aqueous solution containing 50 mM Tris-HCl (pH 8.0) and 1 mM EDTA, and once more subjected to centrifugation at 250,000 x g at 4 °C and for 3 hours to thereby obtain a precipitate. The obtained precipitate was dissolved in 75 ml of 5.5 M GTC solution containing 5.5 M guanidine thiocyanate, 20 mM sodium citrate (pH 7.0), 0.05 % sarkosyl (sodium lauryl sarcosinate) and 0.1 M 2-mercaptoethanol. The resultant solution was applied on 16 ml of CsTFA-0.1 M EDTA
15 solution ($\rho = 1.51$), and subjected to centrifugation at 140,000 x g at 15 °C and for 20 hours to thereby obtain a precipitate of RNA. The supernatant containing proteins and DNA was removed by suction, and the precipitate was dissolved in 200 μ l of TE buffer solution containing 10 mM Tris-HCl (pH 8.0) and 1 mM EDTA. 20 μ l of 3 M sodium chloride and ethanol were added to the solution, and allowed to stand still at -70 °C for 90 minutes. The mixture was centrifuged at 12,000 X g at 4 °C and for 30 minutes to obtain a precipitate. The precipitate
20 was dissolved in TE, and sodium chloride and ethanol were added in the same manner as mentioned above. The mixture was allowed to stand still at -70 °C to obtain a precipitate. The precipitate was dissolved in 10 μ l of TE to thereby obtain a purified RNA.

25 Step 2 (Preparation of a liver-derived RNA for producing a cDNA, which is complementary to NANBV genome RNA)

NANBV genome RNA was prepared from a liver tissue cut off from a NANBV hepatitis patient by the method of Okayama et al. (see H. Okayama, M. Kawaichi, M. Brownstein, F. Lee, T. Yokota, and K. Arai: High-Efficiency Cloning of Full-Length cDNA; Construction and Screening of cDNA Expression Libraries for Mammalian
30 Cells, Methods in Enzymology 154, 3-28, 1987).

Illustratively stated, 1 g of liver tissue was cut into small pieces. The small pieces were suspended in 100 ml of 5.5 M GTC solution as used in Step 1, and homogenized by means of a Teflon-glass homogenizer. Subsequently, the introduction of the homogenate into a syringe having #18 needle and the discharge of the homogenate from the syringe through the needle were repeated to thereby mechanically split DNA. The resultant homogenate was centrifuged at 1,500 x g (lower centrifugal force) at 4 °C and for 15 minutes to thereby
35 obtain a supernatant. The supernatant was superposed on CsTFA solution and centrifuged in substantially the same manner as described in Step 1 to thereby obtain a precipitate as an RNA fraction. The thus obtained precipitate was suspended in 0.4 ml of 4 M GTC solution. 10 μ l of 1 M acetic acid and 300 μ l of ethanol were added to the suspension, and allowed to stand still at -20 °C for at least 3 hours to thereby obtain a precipitate of RNA. The precipitate was separated by centrifugation at 12,000 x g at 4 °C and for 10 minutes, and dissolved in 1
40 ml of TE solution. 100 μ l of 2 M sodium chloride solution and 3 ml of ethanol were added to the solution, and the mixture was allowed to stand still at -20 °C for 3 hours. The resultant precipitate was collected by centrifugation and dissolved in 10 μ l of TE to thereby obtain a purified, liver-derived RNA.

45 Step 3 (Preparation of a double-stranded cDNA using a cDNA synthesis kit)

A double-stranded cDNA was prepared using a commercially available cDNA synthesis kit (manufactured and sold by Amersham International, England).

Illustratively stated, 0.75 μ g of the purified RNA obtained in Step 1 and 2 μ l of random hexanucleotide primer
50 and 2 μ l of reverse transcriptase taken from the reagents included in the kit were put in a reaction tube. Then, distilled water was added in an amount such that the total volume of the resultant mixture became 20 μ l. The mixture was incubated at 42 °C for 40 minutes, thereby preparing a first strand of cDNA. Subsequently, a second strand of cDNA was synthesized while cooling the reaction mixture in ice water, as follows. To 20 μ l of the reaction mixture were added 37.5 μ l of buffer for second strand synthetic reaction, 1 μ l of *E. coli* ribonuclease H
55 and 6.6 μ l of DNA polymerase I, which were taken from the reagents included in the kit, followed by addition of 34.9 μ l of distilled water. The mixture was incubated at 12 °C for 60 minutes, 22 °C for 60 minutes and at 70 °C for 10 minutes. Then, the mixture was once more cooled with ice water. 1 μ l of T4 DNA polymerase was added, incubated at 37 °C for 10 minutes, and 4 μ l of 0.25 M EDTA (pH 8.0) was added to thereby terminate

the reaction. The reaction mixture was mixed well with a mixture of phenol and chloroform, and centrifuged at 12,000 x g for one minute to thereby separate an aqueous layer. The aqueous layer was again subjected to the same extraction as mentioned above, and an equal amount of chloroform was added. The mixture was agitated well and centrifuged to separate an aqueous layer. Subsequently, an equal amount of 4 M ammonium acetate and a two-fold amount of ethanol were added to the aqueous layer, and the mixture was cooled to -70 °C, thereby obtaining a precipitate of purified double-stranded cDNA. The precipitate was dissolved in 50 µl of 2 M ammonium acetate. To the mixture, 100 µl of ethanol was added, and the resultant mixture was cooled to -70 °C to thereby obtain a precipitate. The precipitate was collected by centrifugation at 12,000 x g for ten minutes. The collected precipitate was dried and then, dissolved in 20 µl of TE.

Step 4 (Preparation of a double-stranded cDNA by the Polymerase Chain Reaction (PCR) method)

The cDNAs which were prepared by means of a reverse transcriptase using as templates the RNAs prepared in Steps 1 and 2, were individually amplified by the PCR method (see Saiki, R. K., Gelfand, D. H., Stoffler, S., Scharf, S. J., Higuchi, R., Horn, G. T., Mullis, K. B., and Erlich, H. A., Primer-directed enzymatic amplification of DNA with a thermostable DNA Polymerase, *Science* 239:487-491, 1988). That is, 5 to 1,000 ng of the RNA was incubated in 20 µl of a reverse transcriptase solution containing 50 mM Tris-HCl (pH 8.3), 40 mM KCl, 6 mM MgCl₂, 1 µM 3'-primer [synthesized oligonucleotide comprised of the 7949th to 7973rd 25 nucleotides in Fig. 2(14)], 10 mM dNTP, and 0.5 unit of reverse transcriptase (product of New England Bio Lab., U.S.A.) at 37 °C for 30 minutes. To the resultant mixture was added 80 µl of a PCR reaction solution containing 18 mM Tris-HCl (pH 8.3), 48 mM KCl, 1.5 mM MgCl₂, 0.6 µM each of 5'-primer [synthesized oligonucleotide comprised of the 7612nd to 7636th 25 nucleotides in Fig. 2(13)] and the above-mentioned 3'-primer, 10 mM dNTP and 2.5 units of Taq DNA polymerase (manufactured and sold by Perkin Elmer Cetus Co., Ltd., U.S.A.). The mixture was subjected to incubation at 94 °C for one minute, at 50 °C for 2 minutes and at 72 °C for 3 minutes. This incubation was repeated 40 times. The resultant mixture was subjected to agarose gel electrophoresis, thereby obtaining amplified cDNA. The amplified cDNA was subjected to phenol treatment, ethanol precipitation and drying. The dried cDNA was dissolved in 10 µl of TE.

Step 5 (Preparation of a cDNA library using lambda gt11)

Using a commercially available cDNA cloning kit (manufactured and sold by Amersham International, England), a cDNA library was prepared. That is, to 130 ng of cDNA prepared in step 3 were added 2 µl of L/K buffer, 2 µl of EcoRI adaptor and 2 µl of T4 DNA ligase, which were taken from the reagents included in the cloning kit. Distilled water was added to the solution in an amount such that the total volume of the resultant mixture became 20 µl. The mixture was incubated at 15 °C for 16 to 20 hours, and 2 µl of 0.25 M EDTA was added thereto, to thereby terminate the reaction. Subsequently, the mixture was passed through a size fractionating column included in the kit, thereby removing EcoRI adaptors which were not ligated to the cDNA. To 700 µl of the cDNA having EcoRI adaptor ligated thereto were added 83 µl of L/K buffer and 8 µl of T4 polynucleotide kinase. The mixture was incubated at 37 °C for 30 minutes. The resultant mixture was subjected to phenol extraction twice, concentration to 350 to 400 µl by means of butanol and then ethanol precipitation, thereby obtaining a precipitate. The precipitate was dissolved in 5 µl of TE.

Subsequently, in order to insert the cDNA having EcoRI adaptor ligated thereto to the EcoRI site of cloning vector lambda gt11, 1 µl of L/K buffer, 2 µl (1 µg) of lambda gt11 arm DNA and 2 µl of T4 DNA ligase were added to 1 µl (10 ng) of the above-mentioned cDNA having EcoRI adaptor ligated thereto. Distilled water was added to the mixture in an amount such that the total volume of the mixture became 10 µl. The mixture was incubated at 15 °C for 16 to 20 hours. Thus, a recombinant lambda gt11 DNA solution was prepared. Further, a recombinant lambda phage was obtained by *in vitro* packaging using a commercially available *in vitro* packaging kit (manufactured and sold by Stratagene Co., Ltd., U.S.A.) including Gigapack II Gold solutions A and B, SM buffer and chloroform. That is, 10 µl of Gigapack II Gold solution A and 15 µl of Gigapack II Gold solution B were added to 4 µl of the above-mentioned recombinant lambda gt11 DNA solution. The mixture was incubated at 22 °C for 2 hours to obtain a recombinant phage. After the incubation, 470 µl of SM buffer and 10 µl of chloroform were added and the recombinant phage was stored at 4 °C.

Step 6 (Cloning of cDNA using *E. coli* Plasmid pUC19)

Using a commercially available DNA ligation kit (manufactured and sold by Takara Shuzo Co., Ltd., Japan) including solutions A and B, the cDNA was inserted in *E. coli* plasmid pUC19 (C. Yanishi-Perron, J. Vieira, J. Messing, *Gene* 33, 103, 1985), and cloned in *E. coli*. That is, 40 µl of solution A and 10 µl of solution B were

added to 5 µl of the cDNA prepared by polymerase chain reaction (PCR) in Step 4 and 5 µl (50 ng) of plasmid pUC19 DNA which had been digested with restriction enzyme SmaI and dephosphorylated. The mixture was incubated at 15 °C for 16 hours. *E. coli* strain JM 109 (see Messing, J., Crea, R., and Seeburg, P.H., Nucleic Acids Res. 9, 309, 1981) was transformed with the above-obtained plasmid DNA according to the calcium chloride method (see Mandel, M. and A. Higa, J. Mol. Biol., 53, 154, 1970). Thus, a transformed *E. coli* containing the plasmid having the cDNA ligated thereto was obtained.

Step 7 (Screening of clone having NANBV gene from a cDNA library)

E. coli strain Y 1090 (see Richard A. Young and Ronald W. Davis, Science, 222, 778, 1983) was cultured in 50 ml of LBM medium containing 1 % tryptone, 0.5 % yeast extract, 1 % sodium chloride, 50 µg/ml ampicillin and 0.4 % maltose at 37 °C. The *E. coli* cells in a logarithmic growth phase were suspended in 15 ml of 10 mM magnesium sulfate cooled with ice. The bacteriophage solution obtained in Step 5 was diluted with SM buffer containing 0.1 M sodium chloride, 8 mM magnesium sulfate, 50 mM Tris-HCl (pH 7.5) and 0.01 % gelatin. 0.1 ml of the diluted phage solution was mixed with an equal volume of the above-mentioned *E. coli* cell suspension, and the mixture was incubated at 37 °C for 15 minutes. To the mixture was added 4 ml of soft agar medium containing 1 % tryptone, 0.5 % yeast extract, 0.5 % sodium chloride, 0.25 % magnesium sulfate and 0.7 % agar (pH 7.0) heated to 45 °C. The mixture was spread on L-agar plate containing 1 % tryptone, 0.5 % yeast extract, 1 % sodium chloride, 1.5 % agar and 100 µg/ml ampicillin (pH 7.0), and incubated at 42 °C for 3 hours. Subsequently, 10 mM IPTG (isopropyl β-D-thiogalactopyranoside) was infiltrated into a nitrocellulose filter and the nitrocellulose filter was dried and closely contacted with the plate. The plate in contact with the filter was incubated at 37 °C for 3 hours. The filter was separated, and washed with TBS buffer three times. The washed filter was immersed in 2 % bovine serum albumin solution, and incubated at room temperature for one hour. 1/20 volume of *E. coli* lysate solution included in a commercially available immunoscreening kit (manufactured and sold by Amersham International, England) was added to pooled serum from NANB hepatitis patients, and incubated at room temperature for 30 minutes. Thereafter, the serum was diluted to 50-fold with 0.2 % bovine serum albumin-added TBS buffer, and the filter was immersed in the diluted serum solution, and incubated at room temperature for one hour.

The resultant filter was washed four times with a TBS buffer containing 0.05 % Tween 20. The washed filter was immersed in an antibody solution which had been prepared by diluting a peroxidase-labeled anti-human IgG (manufactured and sold by Cappel Co., Ltd., Germany) 1,000-fold for one hour. The filter was washed with the above-mentioned Tween-TBS buffer, and immersed in a solution prepared by adding 0.4 ml of DAB (3,3'-diaminobenzidine tetrahydrochloride) and 15 µl of a 30 % aqueous hydrogen peroxide solution to 50 ml of a TBS buffer, followed by incubation at room temperature for 5 to 30 minutes to allow color development. The resultant filter was completely washed with distilled water to terminate the reaction.

By the above-mentioned procedure, the obtained plaques were purified. As a result, 9 positive clones were isolated, which were, respectively, designated as BK 102, BK 103, BK 105, BK 106, BK 108, BK 109, BK 110, BK 111 and BK 112. All of these clones did not react with serum from a healthy human, but reacted with serum from a patient suffering from NANB hepatitis. See Table 1.

Table 1

Reactivity between the serum obtained from
a patient suffering from NANB hepatitis and
the recombinant lambda gt11 phage clone

Clone	Serum from healthy person	Serum from NANB hepatitis patient
BK 102	0/10*	10/11
BK 103	0/10	9/11
BK 105	0/10	11/11
BK 106	0/10	11/11
BK 108	0/10	9/11
BK 109	0/10	9/11
BK 110	0/10	9/11
BK 111	0/10	9/11
BK 112	0/10	10/11

* the number of positive samples/the number
of specimens.

Step 8 (Determination of the nucleotide sequence of the obtained clones)

Recombinant phage DNAs of clones BK 102 to BK 112 were purified, and the DNAs were digested with restriction enzyme EcoRI. Then, cDNA fragments of NANBV were isolated and the isolated cDNAs were individually inserted into plasmid pUC19 at EcoRI site. Using the plasmids, *E. Coli* strain JM 109 was transformed in substantially the same manner as in Step 6. Plasmid DNAs were obtained from the transformed *E. coli* and purified. The nucleotide sequence of each of the NANBV cDNAs was determined using 7-DEAZA sequencing kit (manufactured and sold by Takara Shuzo Co., Ltd., Japan; see Mizusawa, S., Nishimura, S. and Seela, F. Nucleic Acids Res., 14, 1319, 1986). The relationship between the nucleotide sequences of the obtained cDNA clones is shown in Fig. 1(1).

Step 9 (Cloning of NANBV cDNA clones from a cDNA library by Genomic Walking)

Probes were prepared by labeling with ³²P-dCTP the cDNA fragments of clone BK 102, clone BK 106 and clone BK 112 which were obtained in Step 8. Using the probes, phage clones containing NANBV cDNAs were obtained by hybridization from the cDNA library of cloning vector lambda gt11 obtained in Step 5. That is, plasmid DNAs were prepared from the transformed *E. coli* with clone BK 102, clone BK 106 and clone BK 112 obtained in Step 8 by the alkali method (see T. Maniatis, E.F. Fritsch, and J. Sambrook: Isolation of Bacteriophage λ and Plasmid DNA: "Molecular Cloning", Cold Spring Harbor Lab., pp 75-96.).

Plasmid DNA of clone BK 102 was digested with restriction enzymes NcoI and HincII, and the resultant 0.7 kb fragments having been on the 5'-terminus side of the DNA were subjected to agarose gel electrophoresis, and collected. Plasmid DNAs of clone BK 106 and clone BK 112 were digested with restriction enzyme NcoI.

In the same manner as mentioned above, 1.1 kb DNA fragments were prepared from clone BK 106, and 0.7 kb fragments having been on the 3'-terminus side were prepared from clone BK 112. 25 ng to 1 µg of DNA fragments were incubated with [α - 32 P]dCTP (3000Ci/mmol; manufactured by Amersham Co., Ltd., England) at 37 °C for 3 to 5 hours, using commercially available DNA labeling kit (manufactured by Nippon Gene Co., Ltd.).

5 Thus, probes for hybridization were prepared.

Subsequently, the cDNA library bacteriophage obtained in Step 5 was incubated at 42 °C in L-agar medium for 3 hours, as described in Step 7. Further, the bacteriophage was incubated at 37 °C for 3 hours, and was cooled. A nitrocellulose filter was contacted with phage plaques, and was allowed to stand still for 30 to 60 seconds. Thus, the phage plaques were adsorbed onto the filter.

10 The filter was subjected to alkali denaturation for 1 to 5 minutes using an aqueous solution containing 0.5 N sodium hydroxide and 1.5 M sodium chloride and to the neutralization with 0.5 M Tris-HCl (pH 8.0) containing 1.5 M sodium chloride for 1 to 5 minutes. The filter was washed with 2 x SSC solution containing 0.3 M sodium chloride and 0.03 M sodium citrate, dried, and baked at 80 °C for 2 hours.

The filter was incubated at 42 °C for 6 hours in a solution for hybridization containing 50 % formamide, 5 x SSC, 5 x Denhart solution, 50 mM phosphoric acid/citric acid buffer (pH 6.5), 100 µg/ml salmon sperm DNA and 0.1 % SDS. Then, the filter was immersed in 300 ml of the hybridization solution having 1 ml of the above-mentioned probe of about 4×10^8 cpm/ml added thereto, and incubated at 42 °C for 16 to 20 hours. The filter was washed with a 2 x SSC solution containing 0.1 % (w/w) SDS four times and with a 0.1 x SSC solution containing 0.1 % (w/w) SDS twice. After the washing, the filter was dried, and was subjected to autoradiography.

20 Thus, hybridization positive clones were isolated. As a result, 27 clones being reactive with the probe derived from clone BK 102, 14 clones being reactive with the probe derived from clone BK 106 and 13 clones being reactive with the probe derived from clone BK 112, were obtained, which were respectively designated as BK 114 to BK 169.

25 The nucleotide sequence of each of clones BK 114 to BK 169 was determined according to the method described in Step 8, followed by mapping for each of the clones. As a result, a map of nucleotide sequence having a length of about 9.5 kb considered to be the approximately total length of the NANBV genome was obtained [see Fig. 1(2)].

Clone BK 157 located on the 5' terminus side was digested with restriction enzyme KpnI to thereby isolate a 0.55 kb fragment having been on the 5'-terminus side. Also, clone BK 116 located on the extreme 3'-terminus side was digested with restriction enzymes HpaI and EcoRI to thereby isolate a 0.55 kb fragment having been on the 3'-terminus side. A probe labeled with 32 P was prepared in the same manner as described above, and the cDNA library bacteriophage obtained in Step 5 was subjected to plaque hybridization. As a result, three new additional clones were separated by the probe derived from the clone BK 157. These new clones were, respectively, designated as clones BK 170, BK 171 and BK 172.

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Step 10 (Analysis of the nucleotide sequence of cDNA)

The entire nucleotide sequence of NANBV gene was determined from the nucleotide sequences of the clones obtained in Steps 8 and 9, and shown in Figs. 2(1) to 2(16). From the Figures, it was assumed that the cloned genomic cDNAs of NANBV were composed of 9416 nucleotides, wherein there was an open reading frame composed of 9030 nucleotides coding for a protein composed of 3010 amino acid residues. The hydrophilicity/hydrophobicity pattern of this protein was similar to that of flavivirus as already reported (see H. Sumiyoshi, C. Mori, I. Fuke et al., Complete Nucleotide Sequence of the Japanese Encephalitis Virus Genome RNA. *Virology*, **161**, 497-510, 1987). Clone BK 157 covers nucleotide numbers 1 to 1962 of Figs. 2(1) to 2(16), clone BK 172 covers nucleotide numbers 5 to 366, clone BK 153 covers nucleotide numbers 338 to 1802, clone BK 138 covers nucleotide numbers 1755 to 5124, clone BK 129 covers nucleotide numbers 4104 to 6973, clone BK 108 covers nucleotide numbers 6886 to 8344 and clone BK 166 covers nucleotide numbers 8082 to 9416. They are preserved as *Escherichia coli* BK 108 (deposited at Fermentation Research Institute, Japan under accession number FERM BP-2971), BK 129 (deposited at Fermentation Research Institute, Japan under accession number FERM BP-2972), BK 138 (deposited at Fermentation Research Institute, Japan under accession number FERM BP-2973), BK 153 (deposited at Fermentation Research Institute, Japan under accession number FERM BP-2974), BK 157 (deposited at Fermentation Research Institute, Japan under accession number FERM BP-3243), BK 166 (deposited at Fermentation Research Institute, Japan under accession number FERM BP-2975), and BK 172 (deposited at Fermentation Research Institute, Japan under accession number FERM BP-2976), respectively.

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Reference Example 1

(Production of NANBV-related antigens in *E. coli*, which antigens are related with the antibody-response accompanying NANBV infection)

5 Respective cDNAs of clone BK 106, clone BK 111 and clone BK 112 each obtained in Step 8 of Example 1 (Part I) and cDNA of clone BK 147 obtained in Step 9 of Example 1 (Part I) were individually inserted into plasmids, and the thus obtained plasmid DNAs were collected by the conventional alkali method. Subsequently, the collected DNA of clone BK 106 was digested with restriction enzymes EcoRI and ClaI to thereby obtain 0.5 μ g of a DNA fragment of 0.34 kb in length. The thus obtained DNA fragment was incubated at 37 °C for 60 minutes in a T4 DNA polymerase solution containing 67 mM Tris-HCl (pH 8.8), 6.7 mM magnesium chloride, 16.6 mM ammonium sulfate, 10 mM 2-mercaptoethanol, 6.7 μ M EDTA, 0.02 % bovine serum albumin, 0.3 mM dNTP and 2-5 units of T4 DNA polymerase, thereby rendering both terminals blunt. The DNA of clone BK 102 was digested with restriction enzyme BamHI to thereby obtain 0.5 μ g of a DNA fragment of 0.7 kb in length, and the terminals of the DNA fragment were rendered blunt using T4 DNA polymerase in substantially the same manner as mentioned above. The DNA of clone BK 147 was digested with restriction enzyme Sau3AI to thereby obtain 0.5 μ g of a DNA fragment of 1 kb in length and the terminals of the DNA fragment were rendered blunt in the same manner as mentioned above. Also, the DNA of clone BK 111 was digested with restriction enzyme EcoRI to thereby obtain 0.5 μ g of a DNA fragment of 1 kb in length, and the terminals of the DNA fragment were rendered blunt in substantially the same manner as mentioned above. Subsequently, the DNA of expression vector pKK 233-2 (Amann, E. and J. Brosius. ATG vector for regulated high-level expression of cloned genes in *Escherichia coli*. Gene, Vol. 40, 183, 1985) was digested with restriction enzyme HindIII. 2 μ g of the resultant DNA was incubated at 37 °C for 20 minutes in a S1 nuclease solution containing 0.3 M sodium chloride, 50 mM sodium acetate (pH 4.5), 1 mM zinc sulfate and 100-200 units of S1 nuclease, and the reaction was terminated by adding 1/10 volume of each of 0.12 M EDTA and 1 M Tris-HCl solution (pH 9.0). Then, phenol extraction was performed, and the vector DNA having blunt terminals was precipitated by ethanol and collected. On the other hand, the DNA of vector pKK 233-2 was digested with restriction enzyme PstI, and the digested DNA was purified by extraction with phenol and precipitation from ethanol. The terminals of 2 μ g of the purified vector DNA which had been cleaved by restriction enzyme PstI were rendered blunt by the above-mentioned T4 DNA polymerase reaction. The thus obtained DNA fragments derived from clone BK 106 and clone BK 111 were each cleaved with restriction enzyme HindIII. 0.5 μ g of each of the cleaved DNA fragments was mixed with 0.5 μ g of a vector DNA having blunt terminals. The DNA fragments derived from clone BK 102 and clone BK 147 were each cleaved with restriction enzyme PstI. 0.5 μ g of each of the cleaved DNA fragments was mixed with 0.5 μ g of a vector DNA having terminals thereof rendered blunt. The volume of each of the mixtures was adjusted to 20 μ l by adding 2 μ l of 10 x ligation solution containing 500 mM Tris-HCl (pH 7.5), 100 mM magnesium chloride, 100 mM DTT and 10 mM ATP, 300-400 units of T4 DNA ligase and distilled water. The mixtures were incubated at 14 °C for 12-18 hours, thereby obtaining plasmids, which were respectively designated as pCE-06, pE-11, pB-02 and pS-09. Using each of these plasmid DNAs, *E. coli* strain JM 109 was transformed in substantially the same manner as described in Step 6 of Example 1 (Part I), thereby obtaining transformed *E. coli*. The transformed *E. coli* was cultured at 37 °C in LB medium (pH 7.5) containing 1 (w/v)% trypton, 0.5 (w/v)% yeast extract and 1 (w/v)% sodium chloride, and when it was in logarithmic growth phase, 1 mM IPTG (isopropyl- β -D-thiogalactopyranoside) was added to the medium. The culturing was further continued for 3 hours. Then, *E. coli* cells were collected by centrifugation (10,000 x g for 15 minutes), and the collected cells were lysed in 50 mM Tris-HCl (pH 8.0). The mixture was subjected to ultrasonic treatment (20 KHz, 600 W, 5 minutes), and centrifuged at 10,000 x g for 15 minutes to thereby obtain a supernatant fraction and a precipitate fraction. Each of the fractions was dissolved in a sample buffer containing of 20 (v/v)% glycerol, 0.1 M Tris-HCl (pH 6.8), 2 (w/v)% SDS, 2 (v/v)% 2-mercaptoethanol and 0.02 % BPB, heated at 100 °C for 3 minutes, and subjected to electrophoresis using 0.1 % SDS-7.5 % polyacrylamide gel to separate protein. After the electrophoresis, the protein was transferred to a nitrocellulose filter by trans blot cell (manufactured and sold by BIO-RAD Co., Ltd., U.S.A.). The filter was immersed in 3 % gelatin solution, and allowed to stand still for 60 minutes. The filter was incubated together with serum from a patient suffering from NANB hepatitis, which had been diluted 100-fold, for 2 to 3 hours at room temperature. The filter was washed with distilled water and then with TTBS solution containing 0.02 M Tris-HCl (pH 7.5), 0.5 M sodium chloride and 0.05 (v/v)% Tween 20. Subsequently, the washed filter was immersed in a 2,000 fold-diluted solution of peroxidase-labeled anti-human IgG antibody, and incubated at room temperature for 90 minutes. The filter was washed with distilled water and then with TTBS solution. The washed filter was immersed in a buffer having, added thereto, coloring agent DAB and 30 %, based on substrate, hydrogen peroxide as described in Step 7 of Example 1 (Part I) for 5 to 30 minutes, following by washing with water, to terminate the reaction.

As a result, as shown in Table 2, all of the antigens produced by the plasmids specifically react with serum

from a patient suffering from NANB hepatitis, thereby demonstrating that the proteins produced by the cDNAs inserted in the plasmids are clinically important.

Table 2

Reactivity evaluated by the Western blot method
between proteins produced by various plasmids and
sera from a patient suffering from NANB hepatitis

Plasmid	origin of cDNA	Extract	Serum from NANB hepatic patient	Serum from healthy human
pCE-066	BK 106	S P	± +	- -
pE-11-89	BK 111	S P	± +	- -
pB-02-10	BK 102	S P	+ -	- -
ps-09-07	BK 109	S P	± +	- -
pKK233-3	-	S P	- -	- -

S: Supernatant by centrifugation

P: Precipitate by centrifugation

+: positive

±: slightly positive

-: negative

Reference Example 2

(Purification of NANBV-related antigens produced by E. coli and reactivity thereof with serum from a patient suffering from hepatitis)

The usefulness of the protein produced by the cDNA which was inserted into an expression vector was demonstrated by purifying the protein and using the purified protein as an antigen for ELISA or radioimmunoassay. That is, the lysate of the transformed E. coli which was obtained in Reference Example 1 was subjected to centrifugation at 10,000 x g for 15 minutes, thereby obtaining a supernatant and a precipitate. For example, the precipitate obtained from transformant JM 109/pCE 066 was suspended in a solution of 100 mM Tris-HCl (pH 8.0) and 0.1 % Triton X-100, and the resultant suspension was subjected to ultrasonic treatment at a frequency of 20 KHz (600 W) for one minute, followed by centrifugation at 21,000 x g for 15 minutes, thereby obtaining a precipitate. The precipitate was re-suspended in a solution of 100 mM Tris-HCl (pH 8.0) and 6 M urea, and then subjected to ultrasonic treatment followed by centrifugation.

The resultant supernatant was dialyzed against a solution of 10 mM phosphate buffer (pH 7.5) and 6 M urea to thereby obtain an antigen solution. 20 ml of the antigen solution was passed through a column (21.5 x 250 mm) packed with hydroxyapatite, which had been equilibrated with the above-mentioned buffer, to cause

the antigen to be adsorbed onto the packing material. The column was subjected to high speed liquid chromatography (HPLC) wherein elution was performed with the above-mentioned buffer having, added thereto, sodium chloride, the concentration of which was varied from 0 to 2 M with a linear concentration gradient, thereby obtaining a fraction containing an antigen. The obtained fraction was dialyzed against 50 mM carbonate buffer (pH 9.6) containing 0.05 % sodium dodecyl sulfate (SDS).

Further, the supernatant obtained by centrifugation (at 10,000 g for 15 minutes) of the lysate of transformant JM 109/pB-02-10 was treated with 35 % saturated ammonium sulfate, and the obtained precipitate was dissolved in 50 mM Tris-HCl (pH 8.5) buffer containing 100 mM 2-mercaptoethanol. The resultant solution was dialyzed against the above-mentioned buffer. Subsequently, 100 ml of the dialysed solution was passed through a column (22.0 x 200 mm) packed with DEAE cellulose, which had been equilibrated with the above-mentioned buffer, to cause the antigen to be adsorbed onto the packing material. The column was subjected to high performance liquid chromatography wherein elution was performed with 50 mM Tris-HCl (pH 8.5) buffer containing 100 mM 2-mercaptoethanol having, added thereto, sodium chloride, the concentration of which was varied from 0 to 2 M with a linear concentration gradient, thereby pooling a fraction containing the antigen.

The fraction was dialyzed against a solution of 10 mM phosphate buffer (pH 6.8) and 100 mM 2-mercaptoethanol. The dialyzed solution was passed through the column of hydroxyapatite for high performance liquid chromatography, which had been equilibrated by the above-mentioned buffer, to cause the antigen to be adsorbed onto the packing material. The column was subjected to high performance liquid chromatography wherein elution was performed with phosphoric acid, the concentration of which was varied with a linear concentration gradient from 10 to 400 mM, thereby pooling a fraction containing the antigen. The resultant fraction was dialyzed against 50 mM carbonate buffer (pH 9.6) containing 0.05 % SDS.

The precipitate obtained by centrifugation of the lysate of transformant JM 109/pE-11-89 was suspended in 10 mM phosphate buffer (pH 5.5). The suspension was subjected to the above-mentioned ultrasonic treatment for one minute, and then subjected to centrifugation at 21,000 x g for 15 minutes. The resultant precipitate was suspended in 100 mM carbonate buffer (pH 10.5) containing 500 mM sodium chloride and 10 mM EDTA. The resultant suspension was again subjected to the ultrasonic treatment for one minute, followed by centrifugation. The resultant supernatant was dialyzed against 30 mM phosphate buffer containing 6 M urea. Subsequently, 20 ml of the dialyzed solution was passed through a CM cellulose column (22 x 200 mm) for high performance liquid chromatography (HPLC), which had been equilibrated with the same buffer as used for the above-mentioned dialysis, to thereby cause the antigen to be adsorbed onto the packing material. The column was subjected to high performance liquid chromatography wherein elution was performed with the above-mentioned buffer having, added thereto, sodium chloride, the concentration of which was varied from 0 to 1.5 M with a linear concentration gradient, obtaining a fraction containing the antigen. The fraction was dialyzed against 50 mM carbonate buffer (pH 9.6) containing 0.05 % SDS, thereby obtaining a solution containing the antigen.

The antigens prepared above were used as an antigen for ELISA for the clinical diagnosis of infection with non-A, non-B hepatitis virus. That is, the protein concentration of each of the above-mentioned purified antigens was adjusted to 1 µg/ml, and put in each well of Microplate Immulone 600 (manufactured and sold by Greiner, Co., Ltd., Germany) in an amount of 100 µl for use in ELISA, which well was allowed to stand still at 4 °C overnight. The contents of the individual wells were washed well three times with PBS-T buffer containing 10 mM phosphate buffer (pH 7.2), 0.8 % sodium chloride and 0.05 % Tween 20, and sample serum diluted with the PBS-T buffer was added in an amount of 100 µl/well, followed by reaction at 37 °C for one hour. The contents of the individual wells were washed three times with the PBS-T buffer, and a peroxidase-labeled anti-human IgG antibody (manufactured and sold by Cappel Co., Ltd., Germany) which had been diluted 8000-fold with PBS-T buffer containing 10 % fetal calf serum was added in an amount of 100 µl/well. The individual well contents were reacted at 37 °C for one hour, and washed with the PBS-T buffer four times. A substrate coloring agent solution composed of 9 ml of 0.05 M citric acid-phosphate buffer and, contained therein, 0.5 µg of o-phenylenediamine and 20 µl of aqueous hydrogen peroxide, was added in an amount of 100 µl/well. The plate was light shielded, and allowed to stand still at room temperature for 60 minutes. 75 µl of 4 N sulfuric acid was added to each of the wells, and the absorbance at 490 nm was determined. The results are shown in Table 3. As apparent from the table, all of the antigens derived from the transformants specifically react with the serum from NANB hepatitis patient, thereby attesting to the usefulness in clinical diagnosis of the antigens produced by the transformants.

Table 3

Reactivity in ELISA between the purified antigens
from various transformed Escherichia coli and
the serum from NANB hepatitis patient

Serum from blood transfused
patient of hepatitis

origin of antigen (transformed <u>Escherichia</u> <u>coli</u>)	acute	chronic	hepato- cirrhosis	hepatoma	healthy human serum
JM109/pCE-066	2/3*	7/8	3/4	3/3	0/10
JM109/pB-02-10	2/3	8/8	4/4	3/3	0/10
JM109/pE-11-89	2/3	8/8	2/4	3/3	0/10

*: the number of positive samples/the number of
samples examined

The same results as shown in Table 3 were also obtained by radioimmunoassay using the above-mentioned antigens. That is, a polystyrene bead of 1/4 inch in diameter (manufactured and sold by Pesel Co., Ltd., Germany) was put in 0.2 ml of each of the above-mentioned purified antigen solutions of 1 µg/ml in concentration, and allowed to stand still at 4 °C overnight. Then, the polystyrene bead was washed five times with the same PBS-T buffer as used in the above-mentioned ELISA, and a sample serum diluted 20 to 2500-fold with the PBS-T buffer was added in an amount of 200 µl/bead. Reaction was performed at 37 °C for 60 min. The polystyrene bead was washed five times with the PBS-T buffer, and ¹²⁵I-labeled anti-human IgG antibody was added in an amount of 200 µl/bead. Reaction was performed at 37 °C for one hour and the bead was washed five times with the PBS-T buffer. The cpm of ¹²⁵I bound to the polystyrene bead was measured, thereby obtaining the same results as shown in Table 3. Thus, the usefulness of the purified antigens obtained above in the clinical diagnosis of infection with NANB hepatitis virus, was demonstrated.

Reference Example 3

[Detection of NANBV nucleic acid according to PCR (Polymerase Chain Reaction) method]

For preventing NANB hepatitis caused by blood transfusion, it is important to determine whether or not any NANBV infection exists in the blood supplied for transfusion. Further, for diagnosing hepatitis, it is extremely clinically important to study whether or not any NANBV infection exists in liver tissue. The NANBV cDNA obtained according to the present invention can be advantageously used for producing a primer for polymerase chain reaction (PCR) useful for detecting NANB hepatitis. That is, as described in Step 1 of Example 1 (Part I), the purification of RNA was performed from 1 ml of each of sera derived from a patient and a healthy human. Likewise, RNA was prepared from liver cells as described in Step 2 of Example 1 (Part I). Subsequently, as described in Step 4 of Example 1 (Part I), PCR and electrophoresis were conducted to thereby prepare cDNAs. According to the customary procedure, whether or not the amplified cDNA was derived from NANBV, was investigated by Southern hybridization using ³²P-labeled probe prepared from the cDNA derived from NANBV cDNA clone BK 108.

The results are shown in Table 4. From the table, it is apparent that the NANBV nucleic acid in serum can be detected and the serum infection with NANBV can be diagnosed by the use of the primer prepared from the nucleotide sequence of the NANBV cDNA obtained according to the present invention and the fragment of

cloned NANBV cDNA as a probe.

Table 4

Detection of NANBV nucleic acid by PCR

10	sample	antibody against NANBV	PCR
	serum from chronic hepatitis patient		
	NANB 1	+	+
	2	+	+
15	HBV carrier 1	-	-
	2	-	-
	healthy human 1	-	-
20	2	-	-
	excised liver from NANB hepatoma-1		+
	cancerous site		+
25	non-cancerous site		+
	excised liver from NANB hepatoma-2		+
	cancerous site		+
30	non-cancerous site		+

Example 1 (Part II)

step 1 (Construction of the plasmids for the expression of the entire coding region of the NANBV genomic cDNA in *E. coli*)

cDNA was isolated from each of clones BK112, BK146, BK147, BK157 and BK166 shown in Fig. 1 (1) and Fig. 1 (2), and plasmids for the expression of the entire coding region of the NANBV gene in *E. coli* were prepared as follows.

The plasmid DNA of clone BK157 was digested with restriction enzyme BamHI and subjected to agarose gel electrophoresis to thereby obtain a DNA fragment of 1.3 kb in length. The DNA fragment was inserted in plasmid pUC19 (manufactured and sold by Takara Shuzo Co., Ltd., Japan) at its BamHI site to thereby obtain plasmid pBam157. The plasmid pBam157 was digested with restriction enzymes XbaI and NcoI to thereby obtain a DNA fragment of about 3.9 kb in length. Separately, an oligonucleotide of 93bp (having 4 nucleotides deleted from the 3'-terminus side) was synthesized by ligating the sequence of the promoter region of 20bp (TAATAC-GACTCACTATAGGG) of bacteriophage T7 RNA polymerase having, attached thereto, XbaI linker sequence to the sequence of nucleotide numbers 1 to 73 shown in Fig. 2(1) having, attached thereto, NcoI linker sequence. The thus obtained oligonucleotide was ligated to the above-mentioned DNA fragment of 3.9 kb, thereby obtaining plasmid pDM-16. Then, pDM-16 was digested with restriction enzymes ClaI and EcoRI to obtain a DNA fragment of about 3.5 kb. Separately, the DNA of clone BK146 was digested with restriction enzymes ClaI and EcoRI to obtain a DNA fragment of 4.1 kb in length. The above-mentioned DNA fragment of about 3.5 kb was ligated to the thus obtained DNA fragment of 4.1 kb, to thereby obtain plasmid pDM-9. Then, plasmid pDM-9 was digested with SacII, thereby obtaining a DNA fragment of 2.7 kb and a DNA fragment of 4.9 kb. The DNA fragment of 4.9 kb was ligated at its SacII site with T4 DNA ligase and then digested with BamHI and EcoRI, thereby obtaining a DNA fragment of about 7.5 kb. Separately, the DNA of clone BK147 was digested with BamHI and EcoRI, thereby obtaining a DNA fragment of about 2 kb. The thus obtained DNA fragment was ligated to the above-mentioned DNA fragment of 7.5 kb to thereby obtain plasmid pBE147. Plas-

mid pBE147 was digested with SacII. The above-mentioned DNA fragment of 2.7 kb derived from pDM-9 was inserted into the SacII-digested pBE147, thereby obtaining plasmid pDM-B3. Plasmid pDM-B3 was digested with XbaI and EcoRI to thereby obtain a DNA fragment of 6.7 kb.

The DNA of clone BK166 was digested with BamHI to obtain a DNA fragment of 1.3 kb. This fragment was inserted in pUC19 at its BamHI site to obtain pBam166. pBam166 was digested with NdeI and HindIII to thereby obtain a DNA fragment of 2.8 kb. The DNA of clone BK112 was digested with EcoRI and NdeI to obtain a DNA fragment of about 1.6 kb. pUC19 was digested with EcoRI and HindIII to obtain a DNA fragment of about 2.6 kb. The above-obtained three types of DNA fragments were mixed and reacted with T4 DNA ligase to thereby obtain plasmid pEN112 in which these fragments were ligated together at their EcoRI site, NdeI site and HindIII site. Plasmid pEN112 was digested with EcoRI and XbaI to obtain a DNA fragment of 2.7 kb. pDM-B3 was digested with EcoRI and XbaI to obtain a fragment of 6.7 kb. The above-mentioned fragment of 2.7 kb was ligated to the fragment of 6.7 kb, and the resultant ligated DNA fragment was inserted in pUC19 at its XbaI site, thereby obtaining plasmids pDM-22 and pDM-18. Plasmid pDM-18 can be used for the transformation of an animal cell or the like so that the cell can produce an NANBV particle. The transformation can also be performed using an RNA prepared by transcribing pDM-18 by means of in vitro Transcription Kit (manufactured and sold by Boehringer Mannheim Yamanouchi, Japan). Plasmid pDM-22, in which the cDNA was inserted in an orientation opposite to that of pDM-18, was digested with HindIII and ClaI to obtain a DNA fragment of about 9 kb.

The DNA of clone BK106 was digested with BamHI to obtain a DNA fragment of about 1.0 kb. This fragment was inserted in plasmid pUC19 at its BamHI site to obtain plasmid pBam106. The thus obtained plasmid DNA was digested with NcoI, and the sticky terminus was rendered blunt with Mang Beak nuclease (manufactured and sold by Takara Shuzo Co., Ltd., Japan). The resultant plasmid was further digested with XbaI, thereby obtaining a fragment of about 3.6 kb. A synthetic oligonucleotide prepared by ligating the sequence of nucleotide numbers 333 to 372 shown in Fig. 2(1) to the downstream of XbaI linker, was ligated to this fragment to thereby obtain plasmid pXb106. Plasmid pXb106 was digested with HindIII and ClaI to obtain a DNA fragment of 0.4 kb. This fragment was ligated to the above-mentioned fragment of about 9 kb derived from plasmid pDM-22 to thereby obtain plasmid pORF-24. Plasmid pORF-24 was digested with XbaI to obtain a DNA fragment of about 9.0 kb. This fragment was ligated to an expression vector (see F. William Studier and B.A. Moffatt, J. Mol. Biol., 189, 113, 1986) having, ligated thereto, T7 RNA polymerase gene promoter, thereby obtaining expression plasmid pJF-22.

Step 2 (Preparation of transformant *E. coli* and culturing thereof)

Using expression plasmid pJF-22 constructed in Step 1, *Escherichia coli* strain JM109 (DE3) (manufactured and sold by Promega Co., U.S.A.) was transformed by the calcium chloride method (Journal of Molecular Biology, 53, 154, 1970), thereby obtaining transformant JM109 (DE3)/pJF-22.

Transformant *E. coli* JM109 (DE3)/pJF-22 was subjected to the subsequent procedure as described in Reference Example 1. That is, the *E. coli* was cultured on LB culture medium, and then 0.5 mM IPTG was added thereto, followed by further culturing for 3 hours. After that period, the cultured cells were collected and heated in a buffer containing 2 % SDS and 2 % 2-mercaptoethanol at 100 °C for 3 minutes. The resultant cells were subjected to electrophoresis using a gel containing 0.1 (w/v)% SDS and 12.5 (w/v)% acrylamide. The resultant protein isolated on the gel was blotted onto a nitrocellulose membrane by means of a trans blot apparatus (manufactured and sold by Nippon Eido Co., Ltd., Japan) and subjected to Western blotting analysis to identify the obtained protein. In the Western blotting analysis, the specific antisera was used which was obtained by purifying the NANBV-related antigen prepared from the transformant obtained in Reference Example 1 and immunizing guinea pigs therewith. As a result of the Western blotting analysis, it was found that the protein produced by transformant JM109 (DE3)/pJF-22 reacted with all of the antisera (see Table 5).

Table 5

Reactivity of protein produced in transformant

E. coli JM109 (DE3)/pJF-22 with NANBV-related
antibody

cell extract	serum from NANB hepatitis patient			guinea pig antiserum		
	pooled serum	acute	chronic	anti- core	anti- NS3	anti- NS5
JM109 (DE3)/ pJF22	++	+	+	+	+	+
JM109 (DE3)	-	-	-	-	-	-

*: Reactivity as measured by Western blotting
analysis.

Thus, it was demonstrated that in this transformant, the expression was attained of the entire coding region of the NANBV gene from the 5'-end of the genome coding for the core antigen through the 3'-end of the genome coding for the non-structural protein NS5. From the results, it is apparent that this transformant can provide an antigen which is extremely useful for producing not only a diagnostic reagent for NANBV infection but also a vaccine for NANBV.

Step 3 (Production of NANBV particles by expression of NANBV genomic cDNA in animal cells)

Plasmid pORF-24 obtained in Step 1 was partially digested with XbaI and subjected to low melting point agarose gel electrophoresis to obtain a DNA fragment of about 9 kb in length. The thus obtained DNA fragment was inserted into plasmid pMAM-neo (available from Clontech, U.S.A.) which had been cleaved with NheI, to thereby construct expression plasmid pMAM-neo10. The expression plasmid was transfected into cells of human hepatocyte Chang Liver (ATCC CCL 13) and Chimpanzee hepatocyte (purchased from Dainippon Pharmaceutical Company, Ltd., Japan) by a calcium phosphate method ("Molecular Cloning", 16.33-16.39, Cold Spring Harbor Laboratory, 1989). The hepatocyte cells having plasmid pMAM-neo10 introduced thereto were rendered resistant to aminoglycoside antibiotic G418 so that the cells were able to form colonies in the presence of G418 in an amount of 600 µg/ml. Utilizing this resistance as a criterion, transformants were selected, followed by cloning. Transformant clones HL-A1 and HL-A2 produced from human hepatocyte and transformant clones CL-B11 and CL-B14 produced from chimpanzee hepatocyte were individually cultured in Eagle's MEM medium having, incorporated therein, 5 (v/v)% fetal calf serum, at 37 °C for 4 days on a cover glass placed in a Petri dish, in the same manner as in Reference Example 4 which will be described later. With respect to the protein produced by the cell culture of each of the above-obtained clones, determination of NANBV antigenicity was conducted by indirect fluorescent antibody technique using specific antisera described in Step 2. As a result, it was found that the protein produced in the G418 resistant cell clone reacted with all of the antisera of guinea pigs immunized with the NANBV-related antigens obtained in Reference Example 1 (see Table 6).

Table 6

Detection by fluorescent antibody technique of
NANBV-related antigens produced in transformant
human or chimpanzee hepatocyte

cell extract	serum from NANB hepatitis patient			guinea pig antiserum		
	pooled serum	acute	chronic	anti- core	anti- NS3	anti- NS5
human hepatocyte-derived						
HL-A1	+	+	+	+	+	+
HL-A2	+	+	+	+	+	+
normal Chang Liver	-	-	-	-	-	-
chimpanzee hepatocyte-derived						
CL-B11	+	+	+	+	+	+
CL-B14	+	+	+	+	+	+
normal Chimp Liver	-	-	-	-	-	-

This fact means that the entire coding region of NANBV gene covering the region coding for the core antigen through the region coding for NS5 was expressed.

Step 4 (Sucrose density-gradient centrifugation of NANBV-related antigens produced by human hepatocyte- and chimpanzee hepatocyte-derived transformant cell clones HL-A1 and CL-B11)

Clones HL-A1 and CL-B11 were individually cultured at 37 °C for 4 days on 5 Petri dishes having a diameter of 9 cm in a CO₂ incubator, in the same manner as in Step 3. The cells were scraped off with a rubber policeman and pooled together with the culture liquid and subjected to ultrasonic treatment at 20 kHz (200 W) for 2 minutes and centrifugation at 5000 x g and at 4 °C for 15 minutes. The resultant supernatant was further subjected to centrifugation at 48000 x g and at 4 °C for 14 hours to obtain a precipitate. The precipitate was suspended in 1 ml of M/75 PBS and subjected to ultrasonic treatment for 2 minutes and sucrose density-gradient centrifugation at 160000 x g and at 4 °C for 15 hours, followed by fractionation. Each fraction was subjected to SDS-polyacrylamide electrophoresis and Western blotting analysis in the same manner as in Step 2, thereby conducting the detection of a core antigen and an envelope antigen. As a result, both antigens were detected at a sucrose density of 40 (w/v)% to 50 (w/v)%, indicating that there were obtained NANBV particles.

Example 2

Step 1 (Construction of a plasmid for the expression in yeast of the entire coding region of the NANBV genomic cDNA and preparation of a transformant yeast)

5 Plasmid pORF24 obtained in Step 1 of Example 1 (Part II) was digested with XbaI to thereby obtain an NANBV cDNA fragment of about 9 kb in the same manner as in Step 1 of Example 1 (Part II). 0.5 µg of this cDNA fragment was dissolved in a T4 DNA polymerase solution containing 67 mM Tris-HCl (pH 8.8), 6.7 mM magnesium chloride, 16.6 mM ammonium sulfate, 10 mM 2-ME, 6.7 mM EDTA-2Na 0.02 (w/v)% bovine albumine and 0.3 mM dNTP, and 2 to 5 units of T4 DNA polymerase (Takara Shuzo Co., Ltd., Japan) was added
10 thereto and the resultant mixture was incubated at 37 °C for 60 minutes, thereby rendering blunt the both terminals of the fragment. Then, XhoI linker (CCTCGAGG) was ligated thereto by means of T4 DNA ligase. Illustratively stated, 0.3 µg of the DNA was dissolved in 21 µl of a 10 x ligation solution containing 500 mM Tris-HCl (pH 7.5), 100 mM magnesium chloride, 100 mM DTT and 10 mM ATP. Added to the resultant mixture were
15 300 to 400 units of T4 DNA ligase (Takara Shuzo Co., Ltd., Japan) and distilled water in an amount such that the total volume became 210 µl, followed by incubation at 14 °C for 18 hours. The thus prepared cDNA fragment was inserted in an expression vector for use in yeast, namely, YEp133PCT (described in U.S. Patent No. 4,810,492) at its XhoI site to thereby obtain expression plasmid pYHC5. With this expression plasmid pYHC5, yeast *S. cerevisiae* (ATCC No. 44772) was transformed by the alkali cation method (Ito, H. et al, J. Bacteriol.,
20 153:163-168, 1983), to thereby obtain transformant yeast YHC5-1. This transformant was designed so that when the culture medium was lack of phosphate ions, the gene for repressive acid phosphatase was activated to cause the transcription of the NANBV cDNA ligated downstream thereof, thereby producing NANBV-related antigens.

25 Step 2 (production of NANBV-related antigens by yeast and characterization thereof)

Transformant yeast YHC5-1 obtained in Step 1 was inoculated into 100 ml of a culture medium prepared by adding 20 µg/ml of each of uracil, L-tryptophan and L-histidine into Burkholder's medium (see Burkholder, P.R. et al, Am.J. Botany, 30, 206-211, 1943) that was a totally synthesized medium containing 1.5 g/l of potassium phosphate monobasic. The inoculated medium was cultured at 30 °C for 24 hours while shaking. The cultured yeast was washed with physiological saline and inoculated into 1000 ml of a fresh medium of the same type as described above except that 1.5 g/l of potassium chloride was contained instead of potassium phosphate monobasic. The inoculated medium was cultured at 30 °C for 24 hours and the resultant cells were collected. The collected cells were suspended in M/75PBS and glass beads (diameter: 0.45-0.55 mm) were added
30 thereto and the suspension was subjected to a Bead Beater (manufactured and sold by Biospec Products, U.S.A.) to thereby disrupt the cells, and then to centrifugation at 10000 x g and at 4 °C for 10 minutes, thereby obtaining a supernatant. The thus obtained supernatant was subjected to SDS-polyacrylamide gel electrophoresis and Western blotting analysis in the same manner as in Step 2 of Example 1 (Part II), thereby examining whether or not NANBV-related antigens had been produced. As a result, it was found that the extract
35 of transformant yeast YHC5-1 reacted with all of the antibodies respectively specific for the core antigen, envelope antigen, NS3 protein and NS5 protein. This fact means that the entire coding region of NANBV gene from the core antigen region through the NS5 region was expressed (see Table 7).

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Table 7

Reactivity of proteins produced by transformant
yeast YHC5-1 with NANBV-related antibodies

cell extract	serum from NANB hepatitis patient			guinea pig antiserum		
	pooled serum	acute	chronic	anti- core	anti- NS3	anti- NS5
YHC5-1	++	+	+	+	+	+
normal <i>S.cerevisiae</i>	-	-	-	-	-	-

* Reactivity as measured by Western blotting
analysis

Further, the cell extract was subjected to sucrose density-gradient centrifugation in the same manner as in Step 4 of Example 1 (Part II). As a result, both of the core antigen and the envelope antigen were detected in a fraction at a sucrose density of 40 (w/v)% to 50 (w/v)%, indicating that there were obtained NANBV particles.

Example 3

Step 1 (Construction of a plasmid for introduction into vaccinia virus)

Plasmid pUV1 (Falko G. Falkner, Sekhar Chakrabarti and Bernard Moss; Nucleic Acid Res., 15 (17), 7192, 1987) was digested with restriction enzyme EcoRI and subjected to phenol extraction and ethanol precipitation, thereby obtaining a DNA. In the same manner as in Reference Example 1, 0.5 µg of this DNA was dissolved in a T4 DNA polymerase solution and 2 to 5 units of T4 DNA polymerase (manufactured and sold by Takara Shuzo Co., Ltd., Japan) was added, followed by incubation at 37 °C for 60 minutes, to thereby render blunt both terminals. Separately, a DNA fragment carrying the entire nucleotide sequence of NANBV gene coding for an NANBV protein was obtained by a method in which plasmid pORF-24 described in Step 1 of Example 1 (Part II) was digested with XbaI or with XbaI and EcoRI to thereby obtain a DNA fragment of about 9 kb or a DNA fragment of 6.4 kb and the obtained DNA fragment was then treated with T4 DNA polymerase, thereby rendering both terminals blunt. 0.5 µg of the thus obtained DNA derived from pUV1 and 0.5 µg of the thus obtained DNA derived from pORF-24 were dissolved in 21 µl of 10 x ligation solution in the same manner as in Reference Example 1 and added thereto were 300 to 400 units of T4 DNA ligase (manufactured and sold by Takara Shuzo Ltd., Japan) and distilled water in an amount such that the total volume became 210 µl, followed by incubation at 14 °C for 12 to 18 hours. Thus, a cDNA derived from NANBV was ligated to pUV1 at its EcoRI site located downstream of the promoter. The ligation reaction mixture was subjected to phenol extraction and the aqueous layer was subjected to ethanol precipitation to collect a DNA. With the DNA, *E. coli* strain JM109 was transformed in accordance with the calcium chloride method, as described in Step 6 of Example 1 (Part I), thereby obtaining plasmid clones pXX-49 and pXX-51 each having an NANBV cDNA fragment of about 9 kb. In addition, plasmid pXE-39 having an NANBV cDNA fragment of about 6.4 kb and lacking the NS5 region of NANBV. The results are shown in Fig. 5.

Reference Example 4

(Culturing of vaccinia virus WR strain)

Vaccinia virus WR strain was cultured by the customary method. Illustratively stated, monolayer-cultured

cells [such as mouse-derived thymidine kinase (TK)-defective cell line L-M(TK⁻) (ATCC CCL-1.3, Dainippon Pharmaceutical Co., Ltd., Japan), simian kidney-derived Vero cells and adult human hepatocyte Chang Liver (ATCC CCL-13, Dainippon Pharmaceutical Co., Ltd., Japan)] were cultured in a Petri dish having a diameter of 6 cm. The resultant cells were inoculated with 0.5 ml of vaccinia virus and allowed to stand at 37 °C for 1 to 2 hours, followed by removing the virus liquid. Then, 5 ml of Eagle's MEM medium (manufactured and sold by Nissui Pharmaceutical Co., Ltd., Japan) having, added thereto, 5 (v/v)% fetal calf serum and the cells were cultured at 37 °C for 24 to 48 hours until satisfactory cytopathiceffect was observed. Then, the virus culture liquid or the infected cells were collected and suspended in MEM and subjected to ultrasonic treatment at 20 kHz (200W) for 2 minutes, thereby obtaining a virus liquid.

Reference Example 5

(Infectivity assay for vaccinia virus by plaque method)

The plaque method was conducted by the customary procedure. Illustratively stated, the cell culture described in Reference Example 4 in a 6 cm-diameter Petri dish is inoculated with the virus liquid obtained in Reference Example 4, which had been diluted 10-fold with M-199 (manufactured and sold by Sigma, U.S.A.), in an amount of 0.1 ml/dish and allowed to stand at 37 °C for 2 hours, thereby adsorbing the virus onto the cells. Then, the inoculum liquid was removed and an agar-containing medium (prepared by adding 3 (v/v)% fetal calf serum, 0.14 (w/v)% NaHCO₃ and 0.8 (w/v)% agar to M-199) was added in an amount of 5 ml/dish. After the agar had solidified at room temperature, culturing was conducted at 37 °C for 24 hours. Then a medium prepared by adding neutral red (manufactured and sold by Wako Pure Chemical Industries, Ltd., Japan) to the above-mentioned agar in an amount of about 0.006 (w/v)% was overlaid in an amount of 2.5 ml/dish, followed by further culturing at 37 °C. The number of the resultant plaques was counted, to thereby determine the infectivity.

Step 2 (Preparation of recombinant vaccinia virus)

Vero cells were cultured for 24 hours in a 9 cm-diameter Petri dish to be used for tissue culture (manufactured and sold by Falcon, U.S.A.). The cultured Vero cells were inoculated with vaccinia virus WR strain (ATCC VR-119) at an MOI (multiplicity of infection) of 0.05 and allowed to stand at 37 °C for 2 hours so as to adsorb the virus onto the cells. After that period, the virus liquid was removed and the cells were washed with MEM twice. Then, 1 µg and 5 µg of the plasmid DNAs obtained in Step 1 of Example 3 were individually subjected to calcium phosphate precipitation of DNA in accordance with the calcium phosphate method (Graham, F.L., van der Eb, A.J.: Virology, 52, 456-467, 1973), thereby obtaining 1 ml of a DNA-calcium phosphate precipitation solution with respect to each plasmid DNA. The thus obtained 1 ml each of DNA-calcium phosphate precipitate solution was added to the above-obtained virus-infected cells and allowed to stand at room temperature for 30 minutes. Then, 15 ml of the virus culture medium as described in Reference Example 4 was added and the resultant mixture was incubated at 37 °C for 3.5 hours. Then the virus culture medium was removed and 15 ml of a fresh virus culture medium was added, followed by culturing at 37 °C for 48 hours. Then the cell culture was subjected to freezing and thawing 3 times, to thereby obtain a virus suspension. The virus suspension was inoculated into L-M(TK⁻) cells cultured in a 6 cm-diameter Petri dish to be used for culturing, in the same manner as in Reference Example 5. After the virus had been adsorbed onto the cells, an agar medium containing 25 µg/ml of 5-Bromo-2'-deoxyuridine (BUdR, manufactured and sold by Sigma, U.S.A.) was added in an amount of 5 ml/dish, followed by culturing at 37 °C for 8 hours. Then, an agar medium containing 25 µg/ml of BUdR and 25 µg/ml of 5-Bromo-4-Chloro-3-Indolyl-β-D-Galactoside (X-Gal, Takara Shuzo Co., Ltd., Japan) was overlaid in an amount 2.5 ml/dish and the cells were further cultured at 37 °C for 2 days. The blue plaques that appeared were collected together with the overlaying agar medium and suspended in 0.5 ml of M-199 and the supernatant was inoculated into L-M(TK⁻) cells in the same manner as described above, followed by plaque cloning 3 times to thereby purify the clones. The thus obtained vaccinia virus was a recombinant vaccinia virus transformed by recombination with a plasmid vector DNA having an NANBV cDNA, and had the β-galactosidase gene and lacked thymidine kinase. The results are shown in Table 8.

Table 8

Characteristics of recombinant vaccinia virus

recombinant vaccinia virus clone	plasmid employed for re- combination	NANBV genome (kb)	thymidine kinase activity	β -galacto- sidase activity
vUV17	pUV1	X	X	O
vUV27	pUV1	X	X	O
VXE17	pXD39	O(6.4)	X	O
VXE28	pXE39	O(6.4)	X	O
vXX19	pXX49	O(9.0)	X	O
vXX29	pXX51	O(9.0)	X	O
vXX39	pXX51	O(9.0)	X	O

Note) O : Observed

X : Not observed

Step 3 (Detection and confirmation by fluorescent antibody technique of production of NANBV-related antigens by recombinant vaccinia virus)

Antigens produced by recombinant vaccinia virus were detected and confirmed by indirect fluorescent antibody technique. L-M(TK⁻) cells were cultured on a cover glass and inoculated with recombinant vaccinia virus which had been diluted 10-fold, and the cells were cultured by the method described in Reference Example 4. After culturing for 48 hours, the cover glass was taken out and washed with M/75 phosphate buffer saline (M/75 PBS) (pH 7.4) three times and then with distilled water one time, followed by air-drying. Then, the cells were fixed by acetone at -20 °C for 5 minutes. An anti-NANBV mouse monoclonal antibody to be used as a primary antibody was obtained from a hybridoma obtained by fusing a mouse myeloma cell with a lymphocyte separated from BALD/C mouse immunized by the customary method using the core antigen and non-structural protein antigens NS-3 and NS-5. A monoclonal antibody specific for the envelope was prepared by using an antigen produced by binding a 16-mer oligopeptide to bovine serum albumin, which 16-mer oligopeptide was comprised of an amino acid sequence (1st to 16th amino acids on the N-terminal side) deduced from the envelope gene. Indirect fluorescent antibody technique was conducted by the customary method. That is, the infected cells fixed by acetone were reacted with the primary antibody at 37 °C for 1 hour and washed with M/75 PBS three times. Then, the cells were reacted with FITC (fluorescent dye)-labeled anti-human or mouse IgG antibody (manufactured and sold by Cappel Co., Ltd., Germany) at 37 °C for 1 hour and washed with M/75 PBS three times, followed by the observation by a fluorescence microscope. The results are shown in Table 9.

Table 9 (1)

Detection by fluorescent antibody technique of
 NANBV-related antigens produced by cells infected
 with recombinant vaccinia virus

recombinant vaccinia virus	serum from healthy human			serum from NANB hepatitis patient			
	#6	#8	#9	pooled serum #II-1	pooled serum #PS-1	acute	chronic
vUV17	-	-	-	-	-	-	-
vUV27	-	-	-	-	-	-	-
vXE17	-	-	-	+	+	+	+
vXE28	-	-	-	+	+	+	+
vXX19	-	-	-	+	+	+	+
vXX29	-	-	-	+	+	+	+
vXX39	-	-	-	+	+	+	+

(to be continued)

Table 9 (2) (continued)

5	recombinant vaccinia virus	monoclonal antibody			
		anti-core #11	anti-Env #755	anti-NS3 #74-1	anti-NS5 #8905
10	vUV17	-	-	-	-
	vUV27	-	-	-	-
15	vXE17	+	+	+	-
	vXE28	+	+	+	-
20	vXX19	+	+	+	+
	vXX29	+	+	+	+
25	vXX39	+	+	+	+

30 Recombinant vaccinia virus clones vXE17 and vXE28, both of which lacked a portion of the nucleotide sequence coding for the NS5 region of NANBV, and clones vXX19, vXX29 and vXX39, all of which had a complete ORF coding for the protein of NANBV, reacted with all of the sera from NANB hepatitis patients but did not react with any of the sera from healthy humans. When a mouse monoclonal antibody was employed, all of clones vXE17 and vXE28 and clones vXX19, vXX29 and vXX39 reacted with the anti-core antigen monoclonal antibody, the anti-envelope antigen monoclonal antibody and the anti-NS3 monoclonal antibody. With respect to the anti-NS5 monoclonal antibody, vXE17 and vXE28, both of which lacked the NS5 region of NANBV, did not react therewith, but vXX19, vXX29 and vXX39 reacted therewith. These facts mean that the desired expression products were advantageously produced by means of recombinant vaccinia virus and that particularly by means of clones vXX19, vXX29 and vXX39, the entire region was expressed, from the core antigen on the N-terminal side of the NANBV protein through the NS5 protein on the C-terminal side thereof.

Step 4 (Analysis of supernatant of culture of cells infected with recombinant vaccinia virus by sucrose density-gradient centrifugation)

45 As described in Reference Example 4, 1.0 ml (1.2×10^7 PFU) of recombinant vaccinia virus vXX39 (1.2×10^7 PFU/ml) was inoculated into a cell culture of human hepatocyte Chang Liver and adsorbed onto the cells at 37 °C for 2 hours and then cultured at 37 °C for 3 days with only M-199. 200 ml of the supernatant of the culture was subjected to centrifugation at 3000 x g for 5 minutes to obtain a supernatant, which was further subjected to centrifugation at 48000 x g and at 4 °C for 14 hours, to obtain a precipitate. The precipitate was suspended in 2 ml of M/75 PBS and subjected to ultrasonic treatment at 20 kHz (200W) for 2 minutes and the resultant product was subjected to sucrose density-gradient centrifugation at 160,000 x g and at 4 °C for 15 hours and wherein the sucrose density was changed from 20 (w/v)% to 60 (w/v)%, thereby obtaining fractions. Each of the fractions was mixed with a sample buffer containing, in the final concentration, 20 (v/v)% glycerol, 100 mM (pH 6.8) Tris-HCl, 2 (w/v)% SDS, 2 (v/v)% 2-mercaptoethanol and 0.02 (w/v)% BPB, and heated at 100 °C for 5 minutes and then subjected to 0.1 (w/v)% SDS-12.5 % polyacrylamide gel electrophoresis, to thereby separate proteins from each other. Then the gel was subjected to a trans blot apparatus (manufactured and sold by Nippon Eido Co., Ltd., Japan), to thereby blot the proteins which were separated by electrophoresis onto Hybond-ECL membrane (manufactured and sold by Amershan, England). The Hybond-ECL membrane

was then immersed in a solution composed of 10 mM Tris-HCl (pH 7.2), 150 mM NaCl, 0.05 (w/v)% Tween-20 (T-TBS) and 5 (w/v)% skim milk, and incubated at room temperature for 1 hour, thereby blocking the membrane. Then, the anti-core antigen monoclonal antibody (clone 29) which had been diluted 500-fold with a T-TBS buffer containing 1 % skim milk was reacted with the Hybond-ECL membrane at 37 °C for 1 hour and then the membrane was washed well 2 times with a fresh one of the above-mentioned T-TBS buffer containing 1 % skim milk. Then, the membrane was reacted with biotin-labeled anti-mouse IgG (manufactured and sold by Cappel Co., Ltd., Germany; diluted 500-fold) at room temperature for 1 hour. The Hybond-ECL membrane was then washed 2 times and reacted with HRPO-labeled streptavidin (manufactured and sold by Amersham, England; diluted 500-fold) at room temperature for 1 hour, and washed well 4 times with T-TBS. The membrane was subjected to chemical luminescence reaction by means of ECL Western blotting detection system (manufactured and sold by Amersham, England). The membrane was wrapped with Saran Wrap and kept in contact with an X-ray film for 30 seconds, followed by the development of the film. As a result, it was found that activities of a core antigen and an envelope antigen of NANBV were observed at a sucrose concentration of 44 to 58 (w/v)% (as shown in Fig. 7). This fact indicates that there were obtained NANBV particles.

Step 5 (Observation of recombinant vaccinia virus-infected cells under electron microscope)

Recombinant vaccinia virus clones vXX39 and vUV17 (the later having no NANBV genome) were cultured on human hepatocyte for 2 days in the same manner as described in Reference Example 4, and the infected cells were collected by means of a rubber police. The collected cells were embedded in an epoxy resin (manufactured and sold by Nissin EM Co., Ltd., Japan) by the customary method and ultra-thin section samples were prepared by slicing. The samples were subjected to uranium-lead double staining, using 2 % uranium acetate and lead citrate, and examined under an electron microscope. As a result, particles were observed in the cells infected with vXX39 as shown in Fig. 8, but not in the cells infected with vUV17 and having no NANBV genome in the cytoplasm. These results, taken together with the results of Step 4, show that vXX39 had produced NANBV particles.

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SEQUENCE LISTING

10

(1) GENERAL INFORMATION:

(i) APPLICANT: THE RESEARCH FOUNDATION OF MICROBIAL DISEASES
OF OSAKA UNIVERSITY

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(ii) TITLE OF INVENTION: NON-A, NON-B HEPATITIS VIRUS GENOMIC
cDNA AND ANTIGEN POLYPEPTIDE

(iii) NUMBER OF SEQUENCES: 2

20

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(v) COMPUTER READABLE FORM:

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(B) COMPUTER: IBM PC compatible
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- 20 (2) INFORMATION FOR SEQ ID NO:1:
- (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 9416 base pairs
 (B) TYPE: nucleic acid
 25 (C) STRANDEDNESS: double
 (D) TOPOLOGY: linear
- (ii) MOLECULE TYPE: DNA (genomic)
- (iii) HYPOTHETICAL: NO
- 30 (iv) ANTI-SENSE: NO
- (v) FRAGMENT TYPE: internal
- (vi) ORIGINAL SOURCE:
 35 (A) ORGANISM: Hepatitis virus
 (B) STRAIN: Non-A, Non-B
 (C) INDIVIDUAL ISOLATE: Human
 (D) DEVELOPMENTAL STAGE: Suspension cells
 (E) HAPLOTYPE: Diploid
 (F) TISSUE TYPE: Liver
 40 (G) CELL TYPE: Hepatocyte
 (H) CELL LINE: ATCC CCL 13
- (vii) IMMEDIATE SOURCE:
 (A) LIBRARY: BK170, BK171, BK172
 (B) CLONE: pDEL-NS5
- 45 (viii) POSITION IN GENOME:
 (A) CHROMOSOME/SEGMENT: N/A
 (B) MAP POSITION: Infectious Agent
 (C) UNITS: bp
- 50 (ix) FEATURE:
 (A) NAME/KEY: CDS

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	120		125		130		135	
10	TAC ATT CCG CTC GTC GGC GCC CCC CTG GGG GGC GCT GCC AGG GCC CTG							785
	Tyr Ile Pro Leu Val Gly Ala Pro Leu Gly Gly Ala Ala Arg Ala Leu							
		140			145		150	
15	GCA CAT GGT GTC CGG GTT CTG GAG GAC GGC GTG AAC TAT GCA ACA GGG							833
	Ala His Gly Val Arg Val Leu Glu Asp Gly Val Asn Tyr Ala Thr Gly							
		155			160		165	
	AAT CTG CCC GGT TGC TCT TTT TCT ATC TTC CTC TTG GCT CTG CTG TCC							881
	Asn Leu Pro Gly Cys Ser Phe Ser Ile Phe Leu Leu Ala Leu Leu Ser							
		170			175		180	
20	TGC CTG ACC ACC CCA GCT TCC GCT TAC GAA GTG CAC AAC GTG TCC GGG							929
	Cys Leu Thr Thr Pro Ala Ser Ala Tyr Glu Val His Asn Val Ser Gly							
		185			190		195	
25	ATA TAT CAT GTC ACG AAC GAC TGC TCC AAC GCA AGC ATT GTG TAT GAG							977
	Ile Tyr His Val Thr Asn Asp Cys Ser Asn Ala Ser Ile Val Tyr Glu							
		200			205		210	215
	GCA GCG GAC TTG ATC ATG CAT ACT CCT GGG TGC GTG CCC TGC GTT CGG							1025
	Ala Ala Asp Leu Ile Met His Thr Pro Gly Cys Val Pro Cys Val Arg							
		220			225		230	
30	GAA GGC AAC TCC TCC CGC TGC TGG GTA GCG CTC ACT CCC ACG CTC GCA							1073
	Glu Gly Asn Ser Ser Arg Cys Trp Val Ala Leu Thr Pro Thr Leu Ala							
		235			240		245	
35	GCC AGG AAC GTC ACC ATC CCC ACC ACG ACG ATA CGA CGC CAC GTC GAT							1121
	Ala Arg Asn Val Thr Ile Pro Thr Thr Thr Ile Arg Arg His Val Asp							
		250			255		260	
	CTG CTC GTT GGG GCG GCT GCT TTC TGT TCC GCT ATG TAC GTG GGG GAC							1169
	Leu Leu Val Gly Ala Ala Ala Phe Cys Ser Ala Met Tyr Val Gly Asp							
		265			270		275	
40	CTC TGC GGA TCT GTT TTC CTC GTC TCT CAG CTG TTC ACC TTC TCG CCT							1217
	Leu Cys Gly Ser Val Phe Leu Val Ser Gln Leu Phe Thr Phe Ser Pro							
		280			285		290	295
45	CGC CGG CAT GTG ACA TTA CAG GAC TGT AAC TGC TCA ATT TAT CCC GGC							1265
	Arg Arg His Val Thr Leu Gln Asp Cys Asn Cys Ser Ile Tyr Pro Gly							
		300			305		310	
50	CAT GTG TCG GGT CAC CGT ATG GCT TGG GAC ATG ATG ATG AAC TGG TCG							1313
	His Val Ser Gly His Arg Met Ala Trp Asp Met Met Met Asn Trp Ser							
		315			320		325	

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10	CCC ACA ACA GCC CTA GTG GTG TCG CAG TTA CTC CGG ATC CCA CAA GCC Pro Thr Thr Ala Leu Val Val Ser Gln Leu Leu Arg Ile Pro Gln Ala 330 335 340	1361
15	GTC GTG GAC ATG GTG GCG GGG GCC CAC TGG GGA GTC CTG GCG GGC CTT Val Val Asp Met Val Ala Gly Ala His Trp Gly Val Leu Ala Gly Leu 345 350 355	1409
20	GCC TAC TAT TCC ATG GCG GGG AAC TGG GCT AAG GTT CTG ATT GTG ATG Ala Tyr Tyr Ser Met Ala Gly Asn Trp Ala Lys Val Leu Ile Val Met 360 365 370 375	1457
25	CTA CTT TTT GCT GGC GTT GAC GGG GAT ACC CAC GTG ACA GGG GGG GCG Leu Leu Phe Ala Gly Val Asp Gly Asp Thr His Val Thr Gly Gly Ala 380 385 390	1505
30	CAA GCC AAA ACC ACC AAC AGG CTC GTG TCC ATG TTC GCA AGT GGG CCG Gln Ala Lys Thr Thr Asn Arg Leu Val Ser Met Phe Ala Ser Gly Pro 395 400 405	1553
35	TCT CAG AAA ATC CAG CTT ATA AAC ACC AAT GGG AGT TGG CAC ATC AAC Ser Gln Lys Ile Gln Leu Ile Asn Thr Asn Gly Ser Trp His Ile Asn 410 415 420	1601
40	AGG ACT GCC CTG AAC TGC AAT GAC TCT CTC CAG ACT GGG TTT CTT GCC Arg Thr Ala Leu Asn Cys Asn Asp Ser Leu Gln Thr Gly Phe Leu Ala 425 430 435	1649
45	GCG CTG TTC TAC ACA CAT AGT TTC AAC TCG TCC GGG TGC CCA GAG CGC Ala Leu Phe Tyr Thr His Ser Phe Asn Ser Ser Gly Cys Pro Glu Arg 440 445 450 455	1697
50	ATG GCC CAG TGC CGC ACC ATT GAC AAG TTC GAC CAG GGA TGG GGT CCC Met Ala Gln Cys Arg Thr Ile Asp Lys Phe Asp Gln Gly Trp Gly Pro 460 465 470	1745
55	ATT ACT TAT GCT GAG TCT AGC AGA TCA GAC CAG AGG CCA TAT TGC TGG Ile Thr Tyr Ala Glu Ser Ser Arg Ser Asp Gln Arg Pro Tyr Cys Trp 475 480 485	1793
60	CAC TAC CCA CCT CCA CAA TGT ACC ATC GTA CCT GCG TCG GAG GTG TGC His Tyr Pro Pro Pro Gln Cys Thr Ile Val Pro Ala Ser Glu Val Cys 490 495 500	1841
65	GGC CCA GTG TAC TGC TTC ACC CCA AGC CCT GTC GTC GTG GGG ACG ACC Gly Pro Val Tyr Cys Phe Thr Pro Ser Pro Val Val Val Gly Thr Thr 505 510 515	1889
70	GAT CGT TTC GGT GTC CCT ACG TAT AGA TGG GGG GAG AAC GAG ACT GAC Asp Arg Phe Gly Val Pro Thr Tyr Arg Trp Gly Glu Asn Glu Thr Asp	1937

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10	520	525	530	535	
	GTG CTG CTG CTC AAC AAC ACG CGG CCG CCG CAA GGC AAC TGG TTC GGC				1985
	Val Leu Leu Leu Asn Asn Thr Arg Pro Pro Gln Gly Asn Trp Phe Gly	540	545	550	
15	TGC ACA TGG ATG AAT AGC ACC GGG TTC ACC AAG ACA TGT GGG GGG CCC				2033
	Cys Thr Trp Met Asn Ser Thr Gly Phe Thr Lys Thr Cys Gly Gly Pro	555	560	565	
20	CCG TGT AAC ATC GGG GGG GTC GGC AAC AAC ACC CTG ACC TGC CCC ACG				2081
	Pro Cys Asn Ile Gly Gly Val Gly Asn Asn Thr Leu Thr Cys Pro Thr	570	575	580	
	GAC TGC TTC CGG AAG CAC CCC GAG GCT ACC TAC ACA AAA TGT GGT TCG				2129
	Asp Cys Phe Arg Lys His Pro Glu Ala Thr Tyr Thr Lys Cys Gly Ser	585	590	595	
25	GGG CCT TGG CTG ACA CCT AGG TGC ATG GTT GAC TAT CCA TAC AGG CTC				2177
	Gly Pro Trp Leu Thr Pro Arg Cys Met Val Asp Tyr Pro Tyr Arg Leu	600	605	610	615
30	TGG CAT TAC CCC TGC ACT GTT AAC TTT ACC ATC TTC AAG GTT AGG ATG				2225
	Trp His Tyr Pro Cys Thr Val Asn Phe Thr Ile Phe Lys Val Arg Met	620	625	630	
	TAT GTG GGG GGG GTG GAG CAC AGG CTC AAT GCT GCA TGC AAT TGG ACC				2273
	Tyr Val Gly Gly Val Glu His Arg Leu Asn Ala Ala Cys Asn Trp Thr	635	640	645	
35	CGA GGA GAG CGT TGT GAC TTG GAG GAC AGG GAT AGG CCG GAG CTC AGC				2321
	Arg Gly Glu Arg Cys Asp Leu Glu Asp Arg Asp Arg Pro Glu Leu Ser	650	655	660	
40	CCG CTG CTG CTG TCT ACA ACA GAG TGG CAG GTA CTG CCC TGT TCC TTC				2369
	Pro Leu Leu Leu Ser Thr Thr Glu Trp Gln Val Leu Pro Cys Ser Phe	665	670	675	
	ACC ACC CTA CCA GCT CTG TCC ACT GGC TTG ATT CAC CTC CAT CAG AAC				2417
	Thr Thr Leu Pro Ala Leu Ser Thr Gly Leu Ile His Leu His Gln Asn	680	685	690	695
45	ATC GTG GAC GTG CAA TAC CTA TAC GGT ATA GGG TCA GCG GTT GTC TCC				2465
	Ile Val Asp Val Gln Tyr Leu Tyr Gly Ile Gly Ser Ala Val Val Ser	700	705	710	
50	TTT GCA ATC AAA TGG GAG TAT GTC CTG TTG CTT TTC CTT CTC CTA GCG				2513
	Phe Ala Ile Lys Trp Glu Tyr Val Leu Leu Leu Phe Leu Leu Leu Ala	715	720	725	

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10	GAC GCA CGT GTC TGT GCC TGC TTG TGG ATG ATG CTG CTG ATA GCC CAG Asp Ala Arg Val Cys Ala Cys Leu Trp Met Met Leu Leu Ile Ala Gln 730 735 740	2561
15	GCC GAG GCC GCC TTG GAG AAC CTG GTG GTC CTC AAT TCG GCG TCT GTG Ala Glu Ala Ala Leu Glu Asn Leu Val Val Leu Asn Ser Ala Ser Val 745 750 755	2609
20	GCC GGC GCA CAT GGC ATC CTC TCC TTC CTT GTG TTC TTC TGT GCC GCC Ala Gly Ala His Gly Ile Leu Ser Phe Leu Val Phe Phe Cys Ala Ala 760 765 770 775	2657
25	TGG TAC ATC AAA GGC AGG CTG GTC CCT GGG GCG ACA TAT GCT CTT TAT Trp Tyr Ile Lys Gly Arg Leu Val Pro Gly Ala Thr Tyr Ala Leu Tyr 780 785 790	2705
30	GGC GTG TGG CCG CTG CTC CTG CTC TTG CTG GCA TTA CCA CCG CGA GCT Gly Val Trp Pro Leu Leu Leu Leu Leu Leu Ala Leu Pro Pro Arg Ala 795 800 805	2753
35	TAC GCC ATG GAC CGG GAG ATG GCT GCA TCG TGC GGA GGC GCG GTT TTT Tyr Ala Met Asp Arg Glu Met Ala Ala Ser Cys Gly Gly Ala Val Phe 810 815 820	2801
40	GTG GGT CTG GTA CTC CTG ACT TTG TCA CCA TAC TAC AAG GTG TTC CTC Val Gly Leu Val Leu Leu Thr Leu Ser Pro Tyr Tyr Lys Val Phe Leu 825 830 835	2849
45	GCT AGG CTC ATA TGG TGG TTA CAA TAT TTT ACC ACC AGA GCC GAG GCG Ala Arg Leu Ile Trp Trp Leu Gln Tyr Phe Thr Thr Arg Ala Glu Ala 840 845 850 855	2897
50	GAC TTA CAT GTG TGG ATC CCC CCC CTC AAC GCT CGG GGA GGC CGC GAT Asp Leu His Val Trp Ile Pro Pro Leu Asn Ala Arg Gly Gly Arg Asp 860 865 870	2945
55	GCC ATC ATC CTC CTC ATG TGC GCA GTC CAT CCA GAG CTA ATC TTT GAC Ala Ile Ile Leu Leu Met Cys Ala Val His Pro Glu Leu Ile Phe Asp 875 880 885	2993
60	ATC ACC AAA CTT CTA ATT GCC ATA CTC GGT CCG CTC ATG GTG CTC CAA Ile Thr Lys Leu Leu Ile Ala Ile Leu Gly Pro Leu Met Val Leu Gln 890 895 900	3041
65	GCT GGC ATA ACC AGA GTG CCG TAC TTC GTG CGC GCT CAA GGG CTC ATT Ala Gly Ile Thr Arg Val Pro Tyr Phe Val Arg Ala Gln Gly Leu Ile 905 910 915	3089
70	CAT GCA TGC ATG TTA GTG CGG AAG GTC GCT GGG GGT CAT TAT GTC CAA His Ala Cys Met Leu Val Arg Lys Val Ala Gly Gly His Tyr Val Gln	3137

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10	920	925	930	935	
	ATG GCC TTC ATG AAG CTG GGC GCG CTG ACA GGC ACG TAC ATT TAC AAC				3185
	Met Ala Phe Met Lys Leu Gly Ala Leu Thr Gly Thr Tyr Ile Tyr Asn				
		940	945	950	
15	CAT CTT ACC CCG CTA CGG GAT TGG CCA CGC GCG GGC CTA CGA GAC CTT				3233
	His Leu Thr Pro Leu Arg Asp Trp Pro Arg Ala Gly Leu Arg Asp Leu				
		955	960	965	
	GCG GTG GCA GTG GAG CCC GTC GTC TTC TCC GAC ATG GAG ACC AAG ATC				3281
	Ala Val Ala Val Glu Pro Val Val Phe Ser Asp Met Glu Thr Lys Ile				
20		970	975	980	
	ATC ACC TGG GGA GCA GAC ACC GCG GCG TGT GGG GAC ATC ATC TTG GGT				3329
	Ile Thr Trp Gly Ala Asp Thr Ala Ala Cys Gly Asp Ile Ile Leu Gly				
		985	990	995	
25	CTG CCC GTC TCC GCC CGA AGG GGA AAG GAG ATA CTC CTG GGC CCG GCC				3377
	Leu Pro Val Ser Ala Arg Arg Gly Lys Glu Ile Leu Leu Gly Pro Ala				
		1000	1005	1010	1015
	GAT AGT CTT GAA GGG CGG GGG TTG CGA CTC CTC GCG CCC ATC ACG GCC				3425
	Asp Ser Leu Glu Gly Arg Gly Leu Arg Leu Leu Ala Pro Ile Thr Ala				
30		1020	1025	1030	
	TAC TCC CAA CAG ACG CGG GGC CTA CTT GGT TGC ATC ATC ACT AGC CTT				3473
	Tyr Ser Gln Gln Thr Arg Gly Leu Leu Gly Cys Ile Ile Thr Ser Leu				
		1035	1040	1045	
35	ACA GGC CGG GAC AAG AAC CAG GTC GAG GGA GAG GTT CAG GTG GTT TCC				3521
	Thr Gly Arg Asp Lys Asn Gln Val Glu Gly Glu Val Gln Val Val Ser				
		1050	1055	1060	
	ACC GCA ACA CAA TCC TTC CTG GCG ACC TGC GTC AAC GGC GTG TGT TGG				3569
	Thr Ala Thr Gln Ser Phe Leu Ala Thr Cys Val Asn Gly Val Cys Trp				
		1065	1070	1075	
40	ACC GTT TAC CAT GGT GCT GGC TCA AAG ACC TTA GCC GCG CCA AAG GGG				3617
	Thr Val Tyr His Gly Ala Gly Ser Lys Thr Leu Ala Ala Pro Lys Gly				
		1080	1085	1090	1095
	CCA ATC ACC CAG ATG TAC ACT AAT GTG GAC CAG GAC CTC GTC GGC TGG				3665
45	Pro Ile Thr Gln Met Tyr Thr Asn Val Asp Gln Asp Leu Val Gly Trp				
		1100	1105	1110	
	CCC AAG CCC CCC GGG GCG CGT TCC TTG ACA CCA TGC ACC TGT GGC AGC				3713
	Pro Lys Pro Pro Gly Ala Arg Ser Leu Thr Pro Cys Thr Cys Gly Ser				
		1115	1120	1125	
50					
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10	TCA GAC CTT TAC TTG GTC ACG AGA CAT GCT GAC GTC ATT CCG GTG CGC Ser Asp Leu Tyr Leu Val Thr Arg His Ala Asp Val Ile Pro Val Arg 1130 1135 1140	3761
15	CGG CGG GGC GAC AGT AGG GGG AGC CTG CTC TCC CCC AGG CCT GTC TCC Arg Arg Gly Asp Ser Arg Gly Ser Leu Leu Ser Pro Arg Pro Val Ser 1145 1150 1155	3809
20	TAC TTG AAG GGC TCT TCG GGT GGT CCA CTG CTC TGC CCC TTC GGG CAC Tyr Leu Lys Gly Ser Ser Gly Gly Pro Leu Leu Cys Pro Phe Gly His 1160 1165 1170 1175	3857
25	GCT GTG GGC ATC TTC CGG GCT GCC GTA TGC ACC CGG GGG GTT GCG AAG Ala Val Gly Ile Phe Arg Ala Ala Val Cys Thr Arg Gly Val Ala Lys 1180 1185 1190	3905
30	GCG GTG GAC TTT GTG CCC GTA GAG TCC ATG GAA ACT ACT ATG CGG TCT Ala Val Asp Phe Val Pro Val Glu Ser Met Glu Thr Thr Met Arg Ser 1195 1200 1205	3953
35	CCG GTC TTC ACG GAC AAC TCA TCC CCC CCG GCC GTA CCG CAG TCA TTT Pro Val Phe Thr Asp Asn Ser Ser Pro Pro Ala Val Pro Gln Ser Phe 1210 1215 1220	4001
40	CAA GTG GCC CAC CTA CAC GCT CCC ACT GGC AGC GGC AAG AGT ACT AAA Gln Val Ala His Leu His Ala Pro Thr Gly Ser Gly Lys Ser Thr Lys 1225 1230 1235	4049
45	GTG CCG GCT GCA TAT GCA GCC CAA GGG TAC AAG GTG CTC GTC CTC AAT Val Pro Ala Ala Tyr Ala Ala Gln Gly Tyr Lys Val Leu Val Leu Asn 1240 1245 1250 1255	4097
50	CCG TCC GTT GCC GCT ACC TTA GGG TTT GGG GCG TAT ATG TCT AAG GCA Pro Ser Val Ala Ala Thr Leu Gly Phe Gly Ala Tyr Met Ser Lys Ala 1260 1265 1270	4145
55	CAC GGT ATT GAC CCC AAC ATC AGA ACT GGG GTA AGG ACC ATT ACC ACA His Gly Ile Asp Pro Asn Ile Arg Thr Gly Val Arg Thr Ile Thr Thr 1275 1280 1285	4193
60	GGC GCC CCC GTC ACA TAC TCT ACC TAT GGC AAG TTT CTT GCC GAT GGT Gly Ala Pro Val Thr Tyr Ser Thr Tyr Gly Lys Phe Leu Ala Asp Gly 1290 1295 1300	4241
65	GGT TGC TCT GGG GGC GCT TAT GAC ATC ATA ATA TGT GAT GAG TGC CAT Gly Cys Ser Gly Gly Ala Tyr Asp Ile Ile Ile Cys Asp Glu Cys His 1305 1310 1315	4289
70	TCA ACT GAC TCG ACT ACA ATC TTG GGC ATC GGC ACA GTC CTG GAC CAA Ser Thr Asp Ser Thr Thr Ile Leu Gly Ile Gly Thr Val Leu Asp Gln	4337

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	1320	1325	1330	1335	
10	GCG GAG ACG GCT GGA GCG CGG CTT GTC GTG CTC GCC ACC GCT ACG CCT Ala Glu Thr Ala Gly Ala Arg Leu Val Val Leu Ala Thr Ala Thr Pro 1340 1345 1350	4385			
15	CCG GGA TCG GTC ACC GTG CCA CAC CCA AAC ATC GAG GAG GTG GCC CTG Pro Gly Ser Val Thr Val Pro His Pro Asn Ile Glu Glu Val Ala Leu 1355 1360 1365	4433			
	TCT AAT ACT GGA GAG ATC CCC TTC TAT GGC AAA GCC ATC CCC ATT GAA Ser Asn Thr Gly Glu Ile Pro Phe Tyr Gly Lys Ala Ile Pro Ile Glu 1370 1375 1380	4481			
20	GCC ATC AGG GGG GGA AGG CAT CTC ATT TTC TGT CAT TCC AAG AAG AAG Ala Ile Arg Gly Gly Arg His Leu Ile Phe Cys His Ser Lys Lys Lys 1385 1390 1395	4529			
25	TGC GAC GAG CTC GCC GCA AAG CTG TCA GGC CTC GGA ATC AAC GCT GTG Cys Asp Glu Leu Ala Ala Lys Leu Ser Gly Leu Gly Ile Asn Ala Val 1400 1405 1410 1415	4577			
	GCG TAT TAC CGG GGG CTC GAT GTG TCC GTC ATA CCA ACT ATC GGA GAC Ala Tyr Tyr Arg Gly Leu Asp Val Ser Val Ile Pro Thr Ile Gly Asp 1420 1425 1430	4625			
30	GTC GTT GTC GTG GCA ACA GAC GCT CTG ATG ACG GGC TAT ACG GGC GAC Val Val Val Val Ala Thr Asp Ala Leu Met Thr Gly Tyr Thr Gly Asp 1435 1440 1445	4673			
35	TTT GAC TCA GTG ATC GAC TGT AAC ACA TGT GTC ACC CAG ACA GTC GAC Phe Asp Ser Val Ile Asp Cys Asn Thr Cys Val Thr Gln Thr Val Asp 1450 1455 1460	4721			
	TTC AGC TTG GAT CCC ACC TTC ACC ATT GAG ACG ACG ACC GTG CCT CAA Phe Ser Leu Asp Pro Thr Phe Thr Ile Glu Thr Thr Thr Val Pro Gln 1465 1470 1475	4769			
40	GAC GCA GTG TCG CGC TCG CAG CGG CGG GGT AGG ACT GGC AGG GGT AGG Asp Ala Val Ser Arg Ser Gln Arg Arg Gly Arg Thr Gly Arg Gly Arg 1480 1485 1490 1495	4817			
45	AGA GGC ATC TAC AGG TTT GTG ACT CCG GGA GAA CGG CCC TCG GGC ATG Arg Gly Ile Tyr Arg Phe Val Thr Pro Gly Glu Arg Pro Ser Gly Met 1500 1505 1510	4865			
50	TTC GAT TCC TCG GTC CTG TGT GAG TGC TAT GAC GCG GGC TGT GCT TGG Phe Asp Ser Ser Val Leu Cys Glu Cys Tyr Asp Ala Gly Cys Ala Trp 1515 1520 1525	4913			

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10	TAC GAG CTC ACC CCG GCC GAG ACC TCG GTT AGG TTG CCG GCC TAC CTG Tyr Glu Leu Thr Pro Ala Glu Thr Ser Val Arg Leu Arg Ala Tyr Leu 1530 1535 1540	4961
15	AAC ACA CCA GGG TTG CCC GTT TGC CAG GAC CAC CTG GAG TTC TGG GAG Asn Thr Pro Gly Leu Pro Val Cys Gln Asp His Leu Glu Phe Trp Glu 1545 1550 1555	5009
20	AGT GTC TTC ACA GGC CTC ACC CAT ATA GAT GCA CAC TTC TTG TCC CAG Ser Val Phe Thr Gly Leu Thr His Ile Asp Ala His Phe Leu Ser Gln 1560 1565 1570 1575	5057
25	ACC AAG CAG GCA GGA GAC AAC TTC CCC TAC CTG GTA GCA TAC CAA GCC Thr Lys Gln Ala Gly Asp Asn Phe Pro Tyr Leu Val Ala Tyr Gln Ala 1580 1585 1590	5105
30	ACG GTG TGC GCC AGG GCT CAG GCC CCA CCT CCA TCA TGG GAT CAA ATG Thr Val Cys Ala Arg Ala Gln Ala Pro Pro Pro Ser Trp Asp Gln Met 1595 1600 1605	5153
35	TGG AAG TGT CTC ATA CCG CTG AAA CCT ACG CTG CAC GGG CCA ACA CCC Trp Lys Cys Leu Ile Arg Leu Lys Pro Thr Leu His Gly Pro Thr Pro 1610 1615 1620	5201
40	TTG CTG TAC AGG CTG GGA GCC GTC CAG AAT GAG GTC ACC CTC ACC CAC Leu Leu Tyr Arg Leu Gly Ala Val Gln Asn Glu Val Thr Leu Thr His 1625 1630 1635	5249
45	CCC ATA ACC AAA TAC ATC ATG GCA TGC ATG TCG GCT GAC CTG GAG GTC Pro Ile Thr Lys Tyr Ile Met Ala Cys Met Ser Ala Asp Leu Glu Val 1640 1645 1650 1655	5297
50	GTC ACT AGC ACC TGG GTG CTG GTG GGC GGA GTC CTT GCA GCT CTG GCC Val Thr Ser Thr Trp Val Leu Val Gly Gly Val Leu Ala Ala Leu Ala 1660 1665 1670	5345
55	GCG TAT TGC CTG ACA ACA GGC AGT GTG GTC ATT GTG GGT AGG ATT ATC Ala Tyr Cys Leu Thr Thr Gly Ser Val Val Ile Val Gly Arg Ile Ile 1675 1680 1685	5393
60	TTG TCC GGG AGG CCG GCC ATT GTT CCC GAC AGG GAG CTT CTC TAC CAG Leu Ser Gly Arg Pro Ala Ile Val Pro Asp Arg Glu Leu Leu Tyr Gln 1690 1695 1700	5441
65	GAG TTC GAT GAA ATG GAA GAG TGC GCC TCG CAC CTC CCT TAC ATC GAG Glu Phe Asp Glu Met Glu Glu Cys Ala Ser His Leu Pro Tyr Ile Glu 1705 1710 1715	5489
70	CAG GGA ATG CAG CTC GCC GAG CAA TTC AAG CAG AAA GCG CTC GGG TTA Gln Gly Met Gln Leu Ala Glu Gln Phe Lys Gln Lys Ala Leu Gly Leu 1720 1725 1730 1735 1740 1745	5537

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	1720	1725	1730	1735	
10	CTG CAA ACA GCC ACC AAA CAA GCG GAG GCT GCT GCT CCC GTG GTG GAG Leu Gln Thr Ala Thr Lys Gln Ala Glu Ala Ala Ala Pro Val Val Glu	1740	1745	1750	5585
15	TCC AAG TGG CGA GCC CTT GAG ACA TTC TGG GCG AAG CAC ATG TGG AAT Ser Lys Trp Arg Ala Leu Glu Thr Phe Trp Ala Lys His Met Trp Asn	1755	1760	1765	5633
20	TTC ATC AGC GGG ATA CAG TAC TTA GCA GGC TTA TCC ACT CTG CCT GGG Phe Ile Ser Gly Ile Gln Tyr Leu Ala Gly Leu Ser Thr Leu Pro Gly	1770	1775	1780	5681
25	AAC CCC GCA ATA GCA TCA TTG ATG GCA TTC ACA GCC TCT ATC ACC AGC Asn Pro Ala Ile Ala Ser Leu Met Ala Phe Thr Ala Ser Ile Thr Ser	1785	1790	1795	5729
30	CCG CTC ACC ACC CAA AGT ACC CTC CTG TTT AAC ATC TTG GGG GGG TGG Pro Leu Thr Thr Gln Ser Thr Leu Leu Phe Asn Ile Leu Gly Gly Trp	1800	1805	1810	5777
35	GTG GCT GCC CAA CTC GCC CCC CCC AGC GCC GCT TCG GCT TTC GTG GGC Val Ala Ala Gln Leu Ala Pro Pro Ser Ala Ala Ser Ala Phe Val Gly	1820	1825	1830	5825
40	GCC GGC ATC GCC GGT GCG GCT GTT GGC AGC ATA GGC CTT GGG AAG GTG Ala Gly Ile Ala Gly Ala Ala Val Gly Ser Ile Gly Leu Gly Lys Val	1835	1840	1845	5873
45	CTT GTG GAC ATT CTG GCG GGT TAT GGA GCA GGA GTG GCC GGC GCG CTC Leu Val Asp Ile Leu Ala Gly Tyr Gly Ala Gly Val Ala Gly Ala Leu	1850	1855	1860	5921
50	GTG GCC TTT AAG GTC ATG AGC GGC GAG ATG CCC TCC ACC GAG GAC CTG Val Ala Phe Lys Val Met Ser Gly Glu Met Pro Ser Thr Glu Asp Leu	1865	1870	1875	5969
55	GTC AAT CTA CTT CCT GCC ATC CTC TCT CCT GGC GCC CTG GTC GTC GGG Val Asn Leu Leu Pro Ala Ile Leu Ser Pro Gly Ala Leu Val Val Gly	1880	1885	1890	6017
60	GTC GTG TGT GCA GCA ATA CTG CGT CGA CAC GTG GGT CCG GGA GAG GGG Val Val Cys Ala Ala Ile Leu Arg Arg His Val Gly Pro Gly Glu Gly	1900	1905	1910	6065
65	GCT GTG CAG TGG ATG AAC CGG CTG ATA GCG TTC GCC TCG CGG GGT AAT Ala Val Gln Trp Met Asn Arg Leu Ile Ala Phe Ala Ser Arg Gly Asn	1915	1920	1925	6113

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10	CAT GTT TCC CCC ACG CAC TAT GTG CCT GAG AGC GAC GCC GCA GCG CGT His Val Ser Pro Thr His Tyr Val Pro Glu Ser Asp Ala Ala Ala Arg 1930 1935 1940	6161
15	GTT ACT CAG ATC CTC TCC AGC CTT ACC ATC ACT CAG CTG CTG AAA AGG Val Thr Gln Ile Leu Ser Ser Leu Thr Ile Thr Gln Leu Leu Lys Arg 1945 1950 1955	6209
20	CTC CAC CAG TGG ATT AAT GAA GAC TGC TCC ACA CCG TGT TCC GGC TCG Leu His Gln Trp Ile Asn Glu Asp Cys Ser Thr Pro Cys Ser Gly Ser 1960 1965 1970 1975	6257
25	TGG CTA AGG GAT GTT TGG GAC TGG ATA TGC ACG GTG TTG ACT GAC TTC Trp Leu Arg Asp Val Trp Asp Trp Ile Cys Thr Val Leu Thr Asp Phe 1980 1985 1990	6305
30	AAG ACC TGG CTC CAG TCC AAG CTC CTG CCG CAG CTA CCT GGA GTC CCT Lys Thr Trp Leu Gln Ser Lys Leu Leu Pro Gln Leu Pro Gly Val Pro 1995 2000 2005	6353
35	TTT TTC TCG TGC CAA CGC GGG TAC AAG GGA GTC TGG CGG GGA GAC GGC Phe Phe Ser Cys Gln Arg Gly Tyr Lys Gly Val Trp Arg Gly Asp Gly 2010 2015 2020	6401
40	ATC ATG CAA ACC ACC TGC CCA TGT GGA GCA CAG ATC ACC GGA CAT GTC Ile Met Gln Thr Thr Cys Pro Cys Gly Ala Gln Ile Thr Gly His Val 2025 2030 2035	6449
45	AAA AAC GGT TCC ATG AGG ATC GTC GGG CCT AAG ACC TGC AGC AAC ACG Lys Asn Gly Ser Met Arg Ile Val Gly Pro Lys Thr Cys Ser Asn Thr 2040 2045 2050 2055	6497
50	TGG CAT GGA ACA TTC CCC ATC AAC GCA TAC ACC ACG GGC CCC TGC ACA Trp His Gly Thr Phe Pro Ile Asn Ala Tyr Thr Thr Gly Pro Cys Thr 2060 2065 2070	6545
55	CCC TCT CCA GCG CCA AAC TAT TCT AGG GCG CTG TGG CGG GTG GCC GCT Pro Ser Pro Ala Pro Asn Tyr Ser Arg Ala Leu Trp Arg Val Ala Ala 2075 2080 2085	6593
60	GAG GAG TAC GTG GAG GTC ACG CGG GTG GGG GAT TTC CAC TAC GTG ACG Glu Glu Tyr Val Glu Val Thr Arg Val Gly Asp Phe His Tyr Val Thr 2090 2095 2100	6641
65	GGC ATG ACC ACT GAC AAC GTA AAG TGC CCA TGC CAG GTT CCG GCT CCT Gly Met Thr Thr Asp Asn Val Lys Cys Pro Cys Gln Val Pro Ala Pro 2105 2110 2115	6689
70	GAA TTC TTC TCG GAG GTG GAC GGA GTG CGG TTG CAC AGG TAC GCT CCG Glu Phe Phe Ser Glu Val Asp Gly Val Arg Leu His Arg Tyr Ala Pro	6737

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10	2120	2125	2130	2135	
	GCG TGC AGG CCT CTC CTA CGG GAG GAG GTT ACA TTC CAG GTC GGG CTC				6785
	Ala Cys Arg Pro Leu Leu Arg Glu Glu Val Thr Phe Gln Val Gly Leu	2140	2145	2150	
15	AAC CAA TAC CTG GTT GGG TCA CAG CTA CCA TGC GAG CCC GAA CCG GAT				6833
	Asn Gln Tyr Leu Val Gly Ser Gln Leu Pro Cys Glu Pro Glu Pro Asp	2155	2160	2165	
20	GTA GCA GTG CTC ACT TCC ATG CTC ACC GAC CCC TCC CAC ATC ACA GCA				6881
	Val Ala Val Leu Thr Ser Met Leu Thr Asp Pro Ser His Ile Thr Ala	2170	2175	2180	
	GAA ACG GCT AAG CGT AGG TTG GCC AGG GGG TCT CCC CCC TCC TTG GCC				6929
	Glu Thr Ala Lys Arg Arg Leu Ala Arg Gly Ser Pro Pro Ser Leu Ala	2185	2190	2195	
25	AGC TCT TCA GCT AGC CAG TTG TCT GCG CCT TCC TTG AAG GCG ACA TGC				6977
	Ser Ser Ser Ala Ser Gln Leu Ser Ala Pro Ser Leu Lys Ala Thr Cys	2200	2205	2210	2215
30	ACT ACC CAC CAT GTC TCT CCG GAC GCT GAC CTC ATC GAG GCC AAC CTC				7025
	Thr Thr His His Val Ser Pro Asp Ala Asp Leu Ile Glu Ala Asn Leu	2220	2225	2230	
	CTG TGG CGG CAG GAG ATG GGC GGG AAC ATC ACC CGC GTG GAG TCG GAG				7073
	Leu Trp Arg Gln Glu Met Gly Gly Asn Ile Thr Arg Val Glu Ser Glu	2235	2240	2245	
35	AAC AAG GTG GTA GTC CTG GAC TCT TTC GAC CCG CTT CGA GCG GAG GAG				7121
	Asn Lys Val Val Val Leu Asp Ser Phe Asp Pro Leu Arg Ala Glu Glu	2250	2255	2260	
40	GAT GAG AGG GAA GTA TCC GTT CCG GCG GAG ATC CTG CGG AAA TCC AAG				7169
	Asp Glu Arg Glu Val Ser Val Pro Ala Glu Ile Leu Arg Lys Ser Lys	2265	2270	2275	
	AAG TTC CCC GCA GCG ATG CCC ATC TGG GCG CGC CCG GAT TAC AAC CCT				7217
	Lys Phe Pro Ala Ala Met Pro Ile Trp Ala Arg Pro Asp Tyr Asn Pro	2280	2285	2290	2295
45	CCA CTG TTA GAG TCC TGG AAG GAC CCG GAC TAC GTC CCT CCG GTG GTG				7265
	Pro Leu Leu Glu Ser Trp Lys Asp Pro Asp Tyr Val Pro Pro Val Val	2300	2305	2310	
50	CAC GGG TGC CCG TTG CCA CCT ATC AAG GCC CCT CCA ATA CCA CCT CCA				7313
	His Gly Cys Pro Leu Pro Pro Ile Lys Ala Pro Pro Ile Pro Pro Pro	2315	2320	2325	

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10	CGG AGA AAG AGG ACG GTT GTC CTA ACA GAG TCC TCC GTG TCT TCT GCC Arg Arg Lys Arg Thr Val Val Leu Thr Glu Ser Ser Val Ser Ser Ala 2330 2335 2340	7361
15	TTA GCG GAG CTC GCT ACT AAG ACC TTC GGC AGC TCC GAA TCA TCG GCC Leu Ala Glu Leu Ala Thr Lys Thr Phe Gly Ser Ser Glu Ser Ser Ala 2345 2350 2355	7409
20	GTC GAC AGC GGC ACG GCG ACC GCC CTT CCT GAC CAG GCC TCC GAC GAC Val Asp Ser Gly Thr Ala Thr Ala Leu Pro Asp Gln Ala Ser Asp Asp 2360 2365 2370 2375	7457
25	GGT GAC AAA GGA TCC GAC GTT GAG TCG TAC TCC TCC ATG CCC CCC CTT Gly Asp Lys Gly Ser Asp Val Glu Ser Tyr Ser Ser Met Pro Pro Leu 2380 2385 2390	7505
30	GAG GGG GAA CCG GGG GAC CCC GAT CTC AGT GAC GGG TCT TGG TCT ACC Glu Gly Glu Pro Gly Asp Pro Asp Leu Ser Asp Gly Ser Trp Ser Thr 2395 2400 2405	7553
35	GTG AGC GAG GAA GCT AGT GAG GAT GTC GTC TGC TGC TCA ATG TCC TAC Val Ser Glu Glu Ala Ser Glu Asp Val Val Cys Cys Ser Met Ser Tyr 2410 2415 2420	7601
40	ACA TGG ACA GGC GCC TTG ATC ACG CCA TGC GCT GCG GAG GAA AGC AAG Thr Trp Thr Gly Ala Leu Ile Thr Pro Cys Ala Ala Glu Glu Ser Lys 2425 2430 2435	7649
45	CTG CCC ATC AAC GCG TTG AGC AAC TCT TTG CTG CGC CAC CAT AAC ATG Leu Pro Ile Asn Ala Leu Ser Asn Ser Leu Leu Arg His His Asn Met 2440 2445 2450 2455	7697
50	GTT TAT GCC ACA ACA TCT CGC AGC GCA GGC CTG CGG CAG AAG AAG GTC Val Tyr Ala Thr Thr Ser Arg Ser Ala Gly Leu Arg Gln Lys Lys Val 2460 2465 2470	7745
55	ACC TTT GAC AGA CTG CAA GTC CTG GAC GAC CAC TAC CGG GAC GTG CTC Thr Phe Asp Arg Leu Gln Val Leu Asp Asp His Tyr Arg Asp Val Leu 2475 2480 2485	7793
60	AAG GAG ATG AAG GCG AAG GCG TCC ACA GTT AAG GCT AAA CTC CTA TCC Lys Glu Met Lys Ala Lys Ala Ser Thr Val Lys Ala Lys Leu Leu Ser 2490 2495 2500	7841
65	GTA GAG GAA GCC TGC AAG CTG ACG CCC CCA CAT TCG GCC AAA TCC AAG Val Glu Glu Ala Cys Lys Leu Thr Pro Pro His Ser Ala Lys Ser Lys 2505 2510 2515	7889
70	TTT GGC TAT GGG GCA AAG GAC GTC CGG AAC CTA TCC AGC AAG GCC GTT Phe Gly Tyr Gly Ala Lys Asp Val Arg Asn Leu Ser Ser Lys Ala Val	7937

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	2520	2525	2530	2535	
10	AAC CAC ATC CAC TCC GTG TGG AAG GAC TTG CTG GAA GAC ACT GTG ACA Asn His Ile His Ser Val Trp Lys Asp Leu Leu Glu Asp Thr Val Thr 2540 2545 2550	7985			
15	CCA ATT GAC ACC ACC ATC ATG GCA AAA AAT GAG GTT TTC TGT GTC CAA Pro Ile Asp Thr Thr Ile Met Ala Lys Asn Glu Val Phe Cys Val Gln 2555 2560 2565	8033			
20	CCA GAG AAA GGA GGC CGT AAG CCA GCC CGC CTT ATC GTA TTC CCA GAT Pro Glu Lys Gly Arg Lys Pro Ala Arg Leu Ile Val Phe Pro Asp 2570 2575 2580	8081			
	CTG GGA GTC CGT GTA TGC GAG AAG ATG GCC CTC TAT GAT GTG GTC TCC Leu Gly Val Arg Val Cys Glu Lys Met Ala Leu Tyr Asp Val Val Ser 2585 2590 2595	8129			
25	ACC CTT CCT CAG GTC GTG ATG GGC TCC TCA TAC GGA TTC CAG TAC TCT Thr Leu Pro Gln Val Val Met Gly Ser Ser Tyr Gly Phe Gln Tyr Ser 2600 2605 2610 2615	8177			
30	CCT GGG CAG CGA GTC GAG TTC CTG GTG AAT ACC TGG AAA TCA AAG AAA Pro Gly Gln Arg Val Glu Phe Leu Val Asn Thr Trp Lys Ser Lys Lys 2620 2625 2630	8225			
	AAC CCC ATG GGC TTT TCA TAT GAC ACT CGC TGT TTC GAC TCA ACG GTC Asn Pro Met Gly Phe Ser Tyr Asp Thr Arg Cys Phe Asp Ser Thr Val 2635 2640 2645	8273			
35	ACC GAG AAC GAC ATC CGT GTT GAG GAG TCA ATT TAC CAA TGT TGT GAC Thr Glu Asn Asp Ile Arg Val Glu Glu Ser Ile Tyr Gln Cys Cys Asp 2650 2655 2660	8321			
40	TTG GCC CCC GAA GCC AGA CAG GCC ATA AAA TCG CTC ACA GAG CGG CTT Leu Ala Pro Glu Ala Arg Gln Ala Ile Lys Ser Leu Thr Glu Arg Leu 2665 2670 2675	8369			
	TAT ATC GGG GGT CCT CTG ACT AAT TCA AAA GGG CAG AAC TGC GGT TAT Tyr Ile Gly Gly Pro Leu Thr Asn Ser Lys Gly Gln Asn Cys Gly Tyr 2680 2685 2690 2695	8417			
45	CGC CGG TGC CGC GCG AGC GGC GTG CTG ACG ACT AGC TGC GGT AAC ACC Arg Arg Cys Arg Ala Ser Gly Val Leu Thr Thr Ser Cys Gly Asn Thr 2700 2705 2710	8465			
50	CTC ACA TGT TAC TTG AAG GCC TCT GCA GCC TGT CGA GCT GCG AAG CTC Leu Thr Cys Tyr Leu Lys Ala Ser Ala Ala Cys Arg Ala Ala Lys Leu 2715 2720 2725	8513			

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10	CAG GAC TGC ACG ATG CTC GTG AAC GGA GAC GAC CTC GTC GTT ATC TGT Gln Asp Cys Thr Met Leu Val Asn Gly Asp Asp Leu Val Val Ile Cys 2730 2735 2740	8561
15	GAA AGC GCG GGA ACC CAA GAG GAC GCG GCG AGC CTA CGA GTC TTC ACG Glu Ser Ala Gly Thr Gln Glu Asp Ala Ala Ser Leu Arg Val Phe Thr 2745 2750 2755	8609
20	GAG GCT ATG ACT AGG TAC TCC GCC CCC CCC GGG GAC CCG CCC CAA CCA Glu Ala Met Thr Arg Tyr Ser Ala Pro Pro Gly Asp Pro Pro Gln Pro 2760 2765 2770 2775	8657
25	GAA TAC GAC TTG GAG CTG ATA ACA TCA TGT TCC TCC AAT GTG TCG GTC Glu Tyr Asp Leu Glu Leu Ile Thr Ser Cys Ser Ser Asn Val Ser Val 2780 2785 2790	8705
30	GCC CAC GAT GCA TCA GGC AAA AGG GTG TAC TAC CTC ACC CGT GAT CCC Ala His Asp Ala Ser Gly Lys Arg Val Tyr Tyr Leu Thr Arg Asp Pro 2795 2800 2805	8753
35	ACC ACC CCC CTA GCA CGG GCT GCG TGG GAG ACA GCT AGA CAC ACT CCA Thr Thr Pro Leu Ala Arg Ala Ala Trp Glu Thr Ala Arg His Thr Pro 2810 2815 2820	8801
40	GTT AAC TCC TGG CTA GGC AAC ATT ATT ATG TAT GCG CCC ACT TTG TGG Val Asn Ser Trp Leu Gly Asn Ile Ile Met Tyr Ala Pro Thr Leu Trp 2825 2830 2835	8849
45	GCA AGG ATG ATT CTG ATG ACT CAC TTC TTC TCC ATC CTT CTA GCG CAG Ala Arg Met Ile Leu Met Thr His Phe Phe Ser Ile Leu Leu Ala Gln 2840 2845 2850 2855	8897
50	GAG CAA CTT GAA AAA GCC CTG GAC TGC CAG ATC TAC GGG GCC TGT TAC Glu Gln Leu Glu Lys Ala Leu Asp Cys Gln Ile Tyr Gly Ala Cys Tyr 2860 2865 2870	8945
55	TCC ATT GAG CCA CTT GAC CTA CCT CAG ATC ATT GAA CGA CTC CAT GGC Ser Ile Glu Pro Leu Asp Leu Pro Gln Ile Ile Glu Arg Leu His Gly 2875 2880 2885	8993
60	CTT AGC GCA TTT TCA CTC CAT AGT TAC TCT CCA GGT GAG ATC AAT AGG Leu Ser Ala Phe Ser Leu His Ser Tyr Ser Pro Gly Glu Ile Asn Arg 2890 2895 2900	9041
65	GTG GCT TCA TGC CTC AGG AAA CTT GGG GTA CCA CCC TTG CGA GTC TGG Val Ala Ser Cys Leu Arg Lys Leu Gly Val Pro Pro Leu Arg Val Trp 2905 2910 2915	9089
70	AGA CAT CGG GCC AGG AGC GTC CGC GCT AGG CTA CTG TCC CAG GGA GGG Arg His Arg Ala Arg Ser Val Arg Ala Arg Leu Leu Ser Gln Gly Gly	9137

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10 2920 2925 2930 2935
 AGG GCC GCC ACT TGT GGC AAA TAC CTC TTC AAC TGG GCA GTA AAA ACC 9185
 Arg Ala Ala Thr Cys Gly Lys Tyr Leu Phe Asn Trp Ala Val Lys Thr
 2940 2945 2950
 15 AAA CTT AAA CTC ACT CCA ATC CCG GCT GCG TCC CGG CTG GAC TTG TCC 9233
 Lys Leu Lys Leu Thr Pro Ile Pro Ala Ala Ser Arg Leu Asp Leu Ser
 2955 2960 2965
 GGC TGG TTC GTT GCT GGT TAC AGC GGG GGA GAC ATA TAT CAC AGC CTG 9281
 Gly Trp Phe Val Ala Gly Tyr Ser Gly Gly Asp Ile Tyr His Ser Leu
 2970 2975 2980
 20 TCT CGT GCC CGA CCC CGT TGG TTC ATG CTG TGC CTA CTC CTA CTT TCT 9329
 Ser Arg Ala Arg Pro Arg Trp Phe Met Leu Cys Leu Leu Leu Leu Ser
 2985 2990 2995
 25 GTA GGG GTA GGC ATC TAC CTG CTC CCC AAC CGA TGAACGGGGA GATAAACA CT 9382
 Val Gly Val Gly Ile Tyr Leu Leu Pro Asn Arg
 3000 3005 3010
 CCAGGCCAAT AGGCCATCCC CCTTTTTTTT TTTT 9416

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(2) INFORMATION FOR SEQ ID NO:2:

(1) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 3010 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

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(11) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:2:

40

Met Ser Thr Asn Pro Lys Pro Gln Arg Lys Thr Lys Arg Asn Thr Asn
 1 5 10 15

Arg Arg Pro Gln Asp Val Lys Phe Pro Gly Gly Gly Gln Ile Val Gly
 20 25 30

45

Gly Val Tyr Leu Leu Pro Arg Arg Gly Pro Arg Leu Gly Val Arg Ala
 35 40 45

Pro Arg Lys Thr Ser Glu Arg Ser Gln Pro Arg Gly Arg Arg Gln Pro
 50 55 60

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Ile Pro Lys Ala Arg Arg Pro Glu Gly Arg Thr Trp Ala Gln Pro Gly
 65 70 75 80

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Tyr Pro Trp Pro Leu Tyr Gly Asn Glu Gly Leu Gly Trp Ala Gly Trp
 85 90 95
 10 Leu Leu Ser Pro Arg Gly Ser Arg Pro Ser Trp Gly Pro Thr Asp Pro
 100 105 110
 Arg Arg Arg Ser Arg Asn Leu Gly Lys Val Ile Asp Thr Leu Thr Cys
 115 120 125
 15 Gly Phe Ala Asp Leu Met Gly Tyr Ile Pro Leu Val Gly Ala Pro Leu
 130 135 140
 Gly Gly Ala Ala Arg Ala Leu Ala His Gly Val Arg Val Leu Glu Asp
 145 150 155 160
 20 Gly Val Asn Tyr Ala Thr Gly Asn Leu Pro Gly Cys Ser Phe Ser Ile
 165 170 175
 Phe Leu Leu Ala Leu Leu Ser Cys Leu Thr Thr Pro Ala Ser Ala Tyr
 180 185 190
 25 Glu Val His Asn Val Ser Gly Ile Tyr His Val Thr Asn Asp Cys Ser
 195 200 205
 Asn Ala Ser Ile Val Tyr Glu Ala Ala Asp Leu Ile Met His Thr Pro
 210 215 220
 30 Gly Cys Val Pro Cys Val Arg Glu Gly Asn Ser Ser Arg Cys Trp Val
 225 230 235 240
 Ala Leu Thr Pro Thr Leu Ala Ala Arg Asn Val Thr Ile Pro Thr Thr
 245 250 255
 35 Thr Ile Arg Arg His Val Asp Leu Leu Val Gly Ala Ala Ala Phe Cys
 260 265 270
 Ser Ala Met Tyr Val Gly Asp Leu Cys Gly Ser Val Phe Leu Val Ser
 275 280 285
 40 Gln Leu Phe Thr Phe Ser Pro Arg Arg His Val Thr Leu Gln Asp Cys
 290 295 300
 Asn Cys Ser Ile Tyr Pro Gly His Val Ser Gly His Arg Met Ala Trp
 305 310 315 320
 45 Asp Met Met Met Asn Trp Ser Pro Thr Thr Ala Leu Val Val Ser Gln
 325 330 335
 50 Leu Leu Arg Ile Pro Gln Ala Val Val Asp Met Val Ala Gly Ala His
 340 345 350

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10 Trp Gly Val Leu Ala Gly Leu Ala Tyr Tyr Ser Met Ala Gly Asn Trp
 355 360 365
 Ala Lys Val Leu Ile Val Met Leu Leu Phe Ala Gly Val Asp Gly Asp
 370 375 380
 15 Thr His Val Thr Gly Gly Ala Gln Ala Lys Thr Thr Asn Arg Leu Val
 385 390 395 400
 Ser Met Phe Ala Ser Gly Pro Ser Gln Lys Ile Gln Leu Ile Asn Thr
 405 410 415
 20 Asn Gly Ser Trp His Ile Asn Arg Thr Ala Leu Asn Cys Asn Asp Ser
 420 425 430
 Leu Gln Thr Gly Phe Leu Ala Ala Leu Phe Tyr Thr His Ser Phe Asn
 435 440 445
 25 Ser Ser Gly Cys Pro Glu Arg Met Ala Gln Cys Arg Thr Ile Asp Lys
 450 455 460
 Phe Asp Gln Gly Trp Gly Pro Ile Thr Tyr Ala Glu Ser Ser Arg Ser
 465 470 475 480
 30 Asp Gln Arg Pro Tyr Cys Trp His Tyr Pro Pro Pro Gln Cys Thr Ile
 485 490 495
 Val Pro Ala Ser Glu Val Cys Gly Pro Val Tyr Cys Phe Thr Pro Ser
 500 505 510
 35 Pro Val Val Val Gly Thr Thr Asp Arg Phe Gly Val Pro Thr Tyr Arg
 515 520 525
 Trp Gly Glu Asn Glu Thr Asp Val Leu Leu Leu Asn Asn Thr Arg Pro
 530 535 540
 40 Pro Gln Gly Asn Trp Phe Gly Cys Thr Trp Met Asn Ser Thr Gly Phe
 545 550 555 560
 Thr Lys Thr Cys Gly Gly Pro Pro Cys Asn Ile Gly Gly Val Gly Asn
 565 570 575
 45 Asn Thr Leu Thr Cys Pro Thr Asp Cys Phe Arg Lys His Pro Glu Ala
 580 585 590
 Thr Tyr Thr Lys Cys Gly Ser Gly Pro Trp Leu Thr Pro Arg Cys Met
 595 600 605
 50 Val Asp Tyr Pro Tyr Arg Leu Trp His Tyr Pro Cys Thr Val Asn Phe
 610 615 620

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Thr Ile Phe Lys Val Arg Met Tyr Val Gly Gly Val Glu His Arg Leu
 625 630 635 640
 10 Asn Ala Ala Cys Asn Trp Thr Arg Gly Glu Arg Cys Asp Leu Glu Asp
 645 650 655
 Arg Asp Arg Pro Glu Leu Ser Pro Leu Leu Leu Ser Thr Thr Glu Trp
 660 665 670
 15 Gln Val Leu Pro Cys Ser Phe Thr Thr Leu Pro Ala Leu Ser Thr Gly
 675 680 685
 Leu Ile His Leu His Gln Asn Ile Val Asp Val Gln Tyr Leu Tyr Gly
 690 695 700
 20 Ile Gly Ser Ala Val Val Ser Phe Ala Ile Lys Trp Glu Tyr Val Leu
 705 710 715 720
 Leu Leu Phe Leu Leu Leu Ala Asp Ala Arg Val Cys Ala Cys Leu Trp
 725 730 735
 25 Met Met Leu Leu Ile Ala Gln Ala Glu Ala Ala Leu Glu Asn Leu Val
 740 745 750
 Val Leu Asn Ser Ala Ser Val Ala Gly Ala His Gly Ile Leu Ser Phe
 755 760 765
 30 Leu Val Phe Phe Cys Ala Ala Trp Tyr Ile Lys Gly Arg Leu Val Pro
 770 775 780
 Gly Ala Thr Tyr Ala Leu Tyr Gly Val Trp Pro Leu Leu Leu Leu Leu
 785 790 795 800
 35 Leu Ala Leu Pro Pro Arg Ala Tyr Ala Met Asp Arg Glu Met Ala Ala
 805 810 815
 Ser Cys Gly Gly Ala Val Phe Val Gly Leu Val Leu Leu Thr Leu Ser
 820 825 830
 40 Pro Tyr Tyr Lys Val Phe Leu Ala Arg Leu Ile Trp Trp Leu Gln Tyr
 835 840 845
 Phe Thr Thr Arg Ala Glu Ala Asp Leu His Val Trp Ile Pro Pro Leu
 850 855 860
 45 Asn Ala Arg Gly Gly Arg Asp Ala Ile Ile Leu Leu Met Cys Ala Val
 865 870 875 880
 50 His Pro Glu Leu Ile Phe Asp Ile Thr Lys Leu Leu Ile Ala Ile Leu
 885 890 895

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10 Gly Pro Leu Met Val Leu Gln Ala Gly Ile Thr Arg Val Pro Tyr Phe
 900 905 910
 Val Arg Ala Gln Gly Leu Ile His Ala Cys Met Leu Val Arg Lys Val
 915 920 925
 15 Ala Gly Gly His Tyr Val Gln Met Ala Phe Met Lys Leu Gly Ala Leu
 930 935 940
 Thr Gly Thr Tyr Ile Tyr Asn His Leu Thr Pro Leu Arg Asp Trp Pro
 945 950 955 960
 20 Arg Ala Gly Leu Arg Asp Leu Ala Val Ala Val Glu Pro Val Val Phe
 965 970 975
 Ser Asp Met Glu Thr Lys Ile Ile Thr Trp Gly Ala Asp Thr Ala Ala
 980 985 990
 25 Cys Gly Asp Ile Ile Leu Gly Leu Pro Val Ser Ala Arg Arg Gly Lys
 995 1000 1005
 Glu Ile Leu Leu Gly Pro Ala Asp Ser Leu Glu Gly Arg Gly Leu Arg
 1010 1015 1020
 30 Leu Leu Ala Pro Ile Thr Ala Tyr Ser Gln Gln Thr Arg Gly Leu Leu
 1025 1030 1035 1040
 Gly Cys Ile Ile Thr Ser Leu Thr Gly Arg Asp Lys Asn Gln Val Glu
 1045 1050 1055
 35 Gly Glu Val Gln Val Val Ser Thr Ala Thr Gln Ser Phe Leu Ala Thr
 1060 1065 1070
 Cys Val Asn Gly Val Cys Trp Thr Val Tyr His Gly Ala Gly Ser Lys
 1075 1080 1085
 40 Thr Leu Ala Ala Pro Lys Gly Pro Ile Thr Gln Met Tyr Thr Asn Val
 1090 1095 1100
 Asp Gln Asp Leu Val Gly Trp Pro Lys Pro Pro Gly Ala Arg Ser Leu
 1105 1110 1115 1120
 45 Thr Pro Cys Thr Cys Gly Ser Ser Asp Leu Tyr Leu Val Thr Arg His
 1125 1130 1135
 Ala Asp Val Ile Pro Val Arg Arg Arg Gly Asp Ser Arg Gly Ser Leu
 1140 1145 1150
 50 Leu Ser Pro Arg Pro Val Ser Tyr Leu Lys Gly Ser Ser Gly Gly Pro
 1155 1160 1165

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10 Leu Leu Cys Pro Phe Gly His Ala Val Gly Ile Phe Arg Ala Ala Val
 1170 1175 1180
 Cys Thr Arg Gly Val Ala Lys Ala Val Asp Phe Val Pro Val Glu Ser
 1185 1190 1195 1200
 15 Met Glu Thr Thr Met Arg Ser Pro Val Phe Thr Asp Asn Ser Ser Pro
 1205 1210 1215
 Pro Ala Val Pro Gln Ser Phe Gln Val Ala His Leu His Ala Pro Thr
 1220 1225 1230
 20 Gly Ser Gly Lys Ser Thr Lys Val Pro Ala Ala Tyr Ala Ala Gln Gly
 1235 1240 1245
 Tyr Lys Val Leu Val Leu Asn Pro Ser Val Ala Ala Thr Leu Gly Phe
 1250 1255 1260
 25 Gly Ala Tyr Met Ser Lys Ala His Gly Ile Asp Pro Asn Ile Arg Thr
 1265 1270 1275 1280
 Gly Val Arg Thr Ile Thr Thr Gly Ala Pro Val Thr Tyr Ser Thr Tyr
 1285 1290 1295
 30 Gly Lys Phe Leu Ala Asp Gly Gly Cys Ser Gly Gly Ala Tyr Asp Ile
 1300 1305 1310
 Ile Ile Cys Asp Glu Cys His Ser Thr Asp Ser Thr Thr Ile Leu Gly
 1315 1320 1325
 35 Ile Gly Thr Val Leu Asp Gln Ala Glu Thr Ala Gly Ala Arg Leu Val
 1330 1335 1340
 Val Leu Ala Thr Ala Thr Pro Pro Gly Ser Val Thr Val Pro His Pro
 1345 1350 1355 1360
 40 Asn Ile Glu Glu Val Ala Leu Ser Asn Thr Gly Glu Ile Pro Phe Tyr
 1365 1370 1375
 Gly Lys Ala Ile Pro Ile Glu Ala Ile Arg Gly Gly Arg His Leu Ile
 1380 1385 1390
 45 Phe Cys His Ser Lys Lys Lys Cys Asp Glu Leu Ala Ala Lys Leu Ser
 1395 1400 1405
 Gly Leu Gly Ile Asn Ala Val Ala Tyr Tyr Arg Gly Leu Asp Val Ser
 1410 1415 1420
 50 Val Ile Pro Thr Ile Gly Asp Val Val Val Val Ala Thr Asp Ala Leu
 1425 1430 1435 1440

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10 Met Thr Gly Tyr Thr Gly Asp Phe Asp Ser Val Ile Asp Cys Asn Thr
 1445 1450 1455
 Cys Val Thr Gln Thr Val Asp Phe Ser Leu Asp Pro Thr Phe Thr Ile
 1460 1465 1470
 15 Glu Thr Thr Thr Val Pro Gln Asp Ala Val Ser Arg Ser Gln Arg Arg
 1475 1480 1485
 Gly Arg Thr Gly Arg Gly Arg Arg Gly Ile Tyr Arg Phe Val Thr Pro
 1490 1495 1500
 20 Gly Glu Arg Pro Ser Gly Met Phe Asp Ser Ser Val Leu Cys Glu Cys
 1505 1510 1515 1520
 Tyr Asp Ala Gly Cys Ala Trp Tyr Glu Leu Thr Pro Ala Glu Thr Ser
 1525 1530 1535
 25 Val Arg Leu Arg Ala Tyr Leu Asn Thr Pro Gly Leu Pro Val Cys Gln
 1540 1545 1550
 Asp His Leu Glu Phe Trp Glu Ser Val Phe Thr Gly Leu Thr His Ile
 1555 1560 1565
 30 Asp Ala His Phe Leu Ser Gln Thr Lys Gln Ala Gly Asp Asn Phe Pro
 1570 1575 1580
 Tyr Leu Val Ala Tyr Gln Ala Thr Val Cys Ala Arg Ala Gln Ala Pro
 1585 1590 1595 1600
 35 Pro Pro Ser Trp Asp Gln Met Trp Lys Cys Leu Ile Arg Leu Lys Pro
 1605 1610 1615
 Thr Leu His Gly Pro Thr Pro Leu Leu Tyr Arg Leu Gly Ala Val Gln
 1620 1625 1630
 40 Asn Glu Val Thr Leu Thr His Pro Ile Thr Lys Tyr Ile Met Ala Cys
 1635 1640 1645
 Met Ser Ala Asp Leu Glu Val Val Thr Ser Thr Trp Val Leu Val Gly
 1650 1655 1660
 45 Gly Val Leu Ala Ala Leu Ala Ala Tyr Cys Leu Thr Thr Gly Ser Val
 1665 1670 1675 1680
 Val Ile Val Gly Arg Ile Ile Leu Ser Gly Arg Pro Ala Ile Val Pro
 1685 1690 1695
 50 Asp Arg Glu Leu Leu Tyr Gln Glu Phe Asp Glu Met Glu Glu Cys Ala
 1700 1705 1710

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Ser His Leu Pro Tyr Ile Glu Gln Gly Met Gln Leu Ala Glu Gln Phe
 1715 1720 1725

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Lys Gln Lys Ala Leu Gly Leu Leu Gln Thr Ala Thr Lys Gln Ala Glu
 1730 1735 1740

Ala Ala Ala Pro Val Val Glu Ser Lys Trp Arg Ala Leu Glu Thr Phe
 1745 1750 1755 1760

20

Trp Ala Lys His Met Trp Asn Phe Ile Ser Gly Ile Gln Tyr Leu Ala
 1765 1770 1775

Gly Leu Ser Thr Leu Pro Gly Asn Pro Ala Ile Ala Ser Leu Met Ala
 1780 1785 1790

Phe Thr Ala Ser Ile Thr Ser Pro Leu Thr Thr Gln Ser Thr Leu Leu
 1795 1800 1805

25

Phe Asn Ile Leu Gly Gly Trp Val Ala Ala Gln Leu Ala Pro Pro Ser
 1810 1815 1820

Ala Ala Ser Ala Phe Val Gly Ala Gly Ile Ala Gly Ala Ala Val Gly
 1825 1830 1835 1840

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Ser Ile Gly Leu Gly Lys Val Leu Val Asp Ile Leu Ala Gly Tyr Gly
 1845 1850 1855

Ala Gly Val Ala Gly Ala Leu Val Ala Phe Lys Val Met Ser Gly Glu
 1860 1865 1870

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Met Pro Ser Thr Glu Asp Leu Val Asn Leu Leu Pro Ala Ile Leu Ser
 1875 1880 1885

Pro Gly Ala Leu Val Val Gly Val Val Cys Ala Ala Ile Leu Arg Arg
 1890 1895 1900

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His Val Gly Pro Gly Glu Gly Ala Val Gln Trp Met Asn Arg Leu Ile
 1905 1910 1915 1920

Ala Phe Ala Ser Arg Gly Asn His Val Ser Pro Thr His Tyr Val Pro
 1925 1930 1935

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Glu Ser Asp Ala Ala Ala Arg Val Thr Gln Ile Leu Ser Ser Leu Thr
 1940 1945 1950

Ile Thr Gln Leu Leu Lys Arg Leu His Gln Trp Ile Asn Glu Asp Cys
 1955 1960 1965

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Ser Thr Pro Cys Ser Gly Ser Trp Leu Arg Asp Val Trp Asp Trp Ile
 1970 1975 1980

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Cys Thr Val Leu Thr Asp Phe Lys Thr Trp Leu Gln Ser Lys Leu Leu
 1985 1990 1995 2000
 10 Pro Gln Leu Pro Gly Val Pro Phe Phe Ser Cys Gln Arg Gly Tyr Lys
 2005 2010 2015
 Gly Val Trp Arg Gly Asp Gly Ile Met Gln Thr Thr Cys Pro Cys Gly
 2020 2025 2030
 15 Ala Gln Ile Thr Gly His Val Lys Asn Gly Ser Met Arg Ile Val Gly
 2035 2040 2045
 Pro Lys Thr Cys Ser Asn Thr Trp His Gly Thr Phe Pro Ile Asn Ala
 2050 2055 2060
 20 Tyr Thr Thr Gly Pro Cys Thr Pro Ser Pro Ala Pro Asn Tyr Ser Arg
 2065 2070 2075 2080
 Ala Leu Trp Arg Val Ala Ala Glu Glu Tyr Val Glu Val Thr Arg Val
 2085 2090 2095
 25 Gly Asp Phe His Tyr Val Thr Gly Met Thr Thr Asp Asn Val Lys Cys
 2100 2105 2110
 Pro Cys Gln Val Pro Ala Pro Glu Phe Phe Ser Glu Val Asp Gly Val
 2115 2120 2125
 Arg Leu His Arg Tyr Ala Pro Ala Cys Arg Pro Leu Leu Arg Glu Glu
 2130 2135 2140
 35 Val Thr Phe Gln Val Gly Leu Asn Gln Tyr Leu Val Gly Ser Gln Leu
 2145 2150 2155 2160
 Pro Cys Glu Pro Glu Pro Asp Val Ala Val Leu Thr Ser Met Leu Thr
 2165 2170 2175
 40 Asp Pro Ser His Ile Thr Ala Glu Thr Ala Lys Arg Arg Leu Ala Arg
 2180 2185 2190
 Gly Ser Pro Pro Ser Leu Ala Ser Ser Ser Ala Ser Gln Leu Ser Ala
 2195 2200 2205
 45 Pro Ser Leu Lys Ala Thr Cys Thr Thr His His Val Ser Pro Asp Ala
 2210 2215 2220
 Asp Leu Ile Glu Ala Asn Leu Leu Trp Arg Gln Glu Met Gly Gly Asn
 2225 2230 2235 2240
 50 Ile Thr Arg Val Glu Ser Glu Asn Lys Val Val Val Leu Asp Ser Phe
 2245 2250 2255

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10 Asp Pro Leu Arg Ala Glu Glu Asp Glu Arg Glu Val Ser Val Pro Ala
 2260 2265 2270
 Glu Ile Leu Arg Lys Ser Lys Lys Phe Pro Ala Ala Met Pro Ile Trp
 2275 2280 2285
 15 Ala Arg Pro Asp Tyr Asn Pro Pro Leu Leu Glu Ser Trp Lys Asp Pro
 2290 2295 2300
 Asp Tyr Val Pro Pro Val Val His Gly Cys Pro Leu Pro Pro Ile Lys
 2305 2310 2315 2320
 20 Ala Pro Pro Ile Pro Pro Pro Arg Arg Lys Arg Thr Val Val Leu Thr
 2325 2330 2335
 Glu Ser Ser Val Ser Ser Ala Leu Ala Glu Leu Ala Thr Lys Thr Phe
 2340 2345 2350
 25 Gly Ser Ser Glu Ser Ser Ala Val Asp Ser Gly Thr Ala Thr Ala Leu
 2355 2360 2365
 Pro Asp Gln Ala Ser Asp Asp Gly Asp Lys Gly Ser Asp Val Glu Ser
 2370 2375 2380
 30 Tyr Ser Ser Met Pro Pro Leu Glu Gly Glu Pro Gly Asp Pro Asp Leu
 2385 2390 2395 2400
 Ser Asp Gly Ser Trp Ser Thr Val Ser Glu Glu Ala Ser Glu Asp Val
 2405 2410 2415
 35 Val Cys Cys Ser Met Ser Tyr Thr Trp Thr Gly Ala Leu Ile Thr Pro
 2420 2425 2430
 Cys Ala Ala Glu Glu Ser Lys Leu Pro Ile Asn Ala Leu Ser Asn Ser
 2435 2440 2445
 40 Leu Leu Arg His His Asn Met Val Tyr Ala Thr Thr Ser Arg Ser Ala
 2450 2455 2460
 Gly Leu Arg Gln Lys Lys Val Thr Phe Asp Arg Leu Gln Val Leu Asp
 2465 2470 2475 2480
 45 Asp His Tyr Arg Asp Val Leu Lys Glu Met Lys Ala Lys Ala Ser Thr
 2485 2490 2495
 Val Lys Ala Lys Leu Leu Ser Val Glu Glu Ala Cys Lys Leu Thr Pro
 2500 2505 2510
 50 Pro His Ser Ala Lys Ser Lys Phe Gly Tyr Gly Ala Lys Asp Val Arg
 2515 2520 2525

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Asn Leu Ser Ser Lys Ala Val Asn His Ile His Ser Val Trp Lys Asp
 2530 2535 2540

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Leu Leu Glu Asp Thr Val Thr Pro Ile Asp Thr Thr Ile Met Ala Lys
 2545 2550 2555 2560

Asn Glu Val Phe Cys Val Gln Pro Glu Lys Gly Gly Arg Lys Pro Ala
 2565 2570 2575

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Arg Leu Ile Val Phe Pro Asp Leu Gly Val Arg Val Cys Glu Lys Met
 2580 2585 2590

Ala Leu Tyr Asp Val Val Ser Thr Leu Pro Gln Val Val Met Gly Ser
 2595 2600 2605

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Ser Tyr Gly Phe Gln Tyr Ser Pro Gly Gln Arg Val Glu Phe Leu Val
 2610 2615 2620

Asn Thr Trp Lys Ser Lys Lys Asn Pro Met Gly Phe Ser Tyr Asp Thr
 2625 2630 2635 2640

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Arg Cys Phe Asp Ser Thr Val Thr Glu Asn Asp Ile Arg Val Glu Glu
 2645 2650 2655

Ser Ile Tyr Gln Cys Cys Asp Leu Ala Pro Glu Ala Arg Gln Ala Ile
 2660 2665 2670

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Lys Ser Leu Thr Glu Arg Leu Tyr Ile Gly Gly Pro Leu Thr Asn Ser
 2675 2680 2685

Lys Gly Gln Asn Cys Gly Tyr Arg Arg Cys Arg Ala Ser Gly Val Leu
 2690 2695 2700

35

Thr Thr Ser Cys Gly Asn Thr Leu Thr Cys Tyr Leu Lys Ala Ser Ala
 2705 2710 2715 2720

Ala Cys Arg Ala Ala Lys Leu Gln Asp Cys Thr Met Leu Val Asn Gly
 2725 2730 2735

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Asp Asp Leu Val Val Ile Cys Glu Ser Ala Gly Thr Gln Glu Asp Ala
 2740 2745 2750

Ala Ser Leu Arg Val Phe Thr Glu Ala Met Thr Arg Tyr Ser Ala Pro
 2755 2760 2765

45

Pro Gly Asp Pro Pro Gln Pro Glu Tyr Asp Leu Glu Leu Ile Thr Ser
 2770 2775 2780

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Cys Ser Ser Asn Val Ser Val Ala His Asp Ala Ser Gly Lys Arg Val
 2785 2790 2795 2800

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Tyr Tyr Leu Thr Arg Asp Pro Thr Thr Pro Leu Ala Arg Ala Ala Trp
2805 2810 2815

Glu Thr Ala Arg His Thr Pro Val Asn Ser Trp Leu Gly Asn Ile Ile
2820 2825 2830

15

Met Tyr Ala Pro Thr Leu Trp Ala Arg Met Ile Leu Met Thr His Phe
2835 2840 2845

Phe Ser Ile Leu Leu Ala Gln Glu Gln Leu Glu Lys Ala Leu Asp Cys
2850 2855 2860

20

Gln Ile Tyr Gly Ala Cys Tyr Ser Ile Glu Pro Leu Asp Leu Pro Gln
2865 2870 2875 2880

Ile Ile Glu Arg Leu His Gly Leu Ser Ala Phe Ser Leu His Ser Tyr
2885 2890 2895

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Ser Pro Gly Glu Ile Asn Arg Val Ala Ser Cys Leu Arg Lys Leu Gly
2900 2905 2910

Val Pro Pro Leu Arg Val Trp Arg His Arg Ala Arg Ser Val Arg Ala
2915 2920 2925

30

Arg Leu Leu Ser Gln Gly Gly Arg Ala Ala Thr Cys Gly Lys Tyr Leu
2930 2935 2940

Phe Asn Trp Ala Val Lys Thr Lys Leu Lys Leu Thr Pro Ile Pro Ala
2945 2950 2955 2960

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Ala Ser Arg Leu Asp Leu Ser Gly Trp Phe Val Ala Gly Tyr Ser Gly
2965 2970 2975

Gly Asp Ile Tyr His Ser Leu Ser Arg Ala Arg Pro Arg Trp Phe Met
2980 2985 2990

40

Leu Cys Leu Leu Leu Leu Ser Val Gly Val Gly Ile Tyr Leu Leu Pro
2995 3000 3005

Asn Arg
3010

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Claims

- 5 1. An isolated non-A, non-B hepatitis virus particle comprising at least one antigen selected from the group consisting of a core antigen, a matrix antigen and an envelope antigen of the non-A, non-B hepatitis virus.
2. The non-A, non-B hepatitis virus particle according to claim 1, wherein said core antigen, matrix antigen and envelope antigen are, respectively, coded for by a nucleotide sequence of the 333rd to 677th nucleotides, a nucleotide sequence of the 678th to 905th nucleotides and a nucleotide sequence of the 906th to 1499th nucleotides of the non-A, non-B hepatitis virus entire nucleotide sequence from the 1st to 9416th nucleotides shown in Fig. 2(1) through Fig. 2 (16) hereof.
- 10 3. The non-A, non-B hepatitis virus particle according to claim 1 or 2, which has a ribonucleic acid corresponding to at least part of the nucleotide sequence shown in Fig. 2(1) through Fig. 2(16) hereof.
- 15 4. A method for producing an isolated non-A, non-B hepatitis virus particle, which comprises:
 - (a) providing not more than ten different cDNA clones each comprising at least 1000 nucleotides and prepared from a non-A, non-B hepatitis virus genomic RNA fragment of at least 1000 nucleotides, said not more than ten different cDNA clones containing their respective cloned cDNA fragments which, on the whole, cover a region of at least the 333rd to 5177th nucleotides of the non-A, non-B hepatitis virus entire nucleotide sequence from the 1st to 9416th nucleotides shown in Fig. 2(1) through Fig. 2(16) hereof;
 - 20 (b) taking out said cDNA fragments from said cDNA clones by cutting so as to respectively have predetermined nucleotide sequences such that when the predetermined nucleotide sequences are arranged in sequence, the resultant nucleotide sequence has at least a region which coincides with the region of the 333rd to 5177th nucleotides;
 - 25 (c) ligating said taken-out cDNA fragments respectively having said predetermined nucleotide sequences in sequence to thereby construct a first deoxyribonucleic acid comprising a nucleotide sequence comprising at least the 333rd to 5177th nucleotides of the non-A, non-B hepatitis virus entire nucleotide sequence from the 1st to 9416th nucleotides shown in Fig. 2(1) through Fig. 2(16) hereof;
 - 30 (d) introducing at least one deoxyribonucleic acid selected from said first deoxyribonucleic acid and a second deoxyribonucleic acid obtained by substituting at least one nucleotide of the nucleotide sequence of said first deoxyribonucleic acid in accordance with the degeneracy of the genetic code into a replicable expression vector selected from a plasmid and an animal virus gene to obtain a replicable recombinant DNA comprising said plasmid and said at least one deoxyribonucleic acid introduced therein when said replicable expression vector is a plasmid or obtain a recombinant virus comprising said animal virus and said at least one deoxyribonucleic acid introduced therein when said replicable expression vector is an animal virus gene;
 - 35 (e) transfecting prokaryotic or eukaryotic cells with said recombinant DNA when said replicable expression vector used in step (d) is a plasmid, to thereby form a transformant, followed by selection of said transformant from parent cells of the prokaryotic or eukaryotic cell culture;
 - 40 (f) culturing said transformant obtained in step (e) in prokaryotic or eukaryotic cells to thereby produce a non-A, non-B hepatitis virus particle, or culturing said recombinant virus obtained in step (d,) in eukaryotic cells to thereby produce a non-A, non-B hepatitis virus particle together with an animal virus;
 - 45 and
 - (g) isolating said non-A, non-B hepatitis virus particle.
- 50 5. The method according to claim 4, wherein said first deoxyribonucleic acid comprises a nucleotide sequence of the 333rd to 5918th nucleotides.
6. The method according to claim 4, wherein said first deoxyribonucleic acid comprises a nucleotide sequence of the 333rd to 6371st nucleotides.
- 55 7. The method according to claim 4, wherein said first deoxyribonucleic acid comprises a nucleotide sequence of the 333rd to 9362nd nucleotides.
8. The method according to claim 4, wherein said first deoxyribonucleic acid comprises a nucleotide sequ-

ence of the 1st to 9416th nucleotides.

9. A recombinant comprising a replicable expression vector selected from a plasmid and an animal virus gene and a deoxyribonucleic acid comprising at least one nucleotide sequence selected from the group consisting of a first nucleotide sequence of the 333rd to 5177th nucleotides of the non-A, non-B hepatitis virus entire nucleotide sequence from the 1st to 9416th nucleotides shown in Fig. 2(1) through Fig. 2(16) hereof and a second nucleotide sequence obtained by substituting at least one nucleotide of said first nucleotide sequence in accordance with the degeneracy of the genetic code.
10. The recombinant according to claim 9, wherein said first nucleotide sequence comprises a nucleotide sequence of the 333rd to 5918th nucleotides.
11. The recombinant according to claim 9, wherein said first nucleotide sequence comprises a nucleotide sequence of the 333rd to 6371st nucleotides.
12. The recombinant according to claim 9, wherein said first nucleotide sequence comprises a nucleotide sequence of the 333rd to 9362nd nucleotides.
13. The recombinant according to claim 9, wherein said first nucleotide sequence comprises a nucleotide sequence of the 1st to 9416th nucleotides.
14. A diagnostic agent for the detection of non-A, non-B hepatitis by an antigen-antibody reaction, comprising an effective amount, for the antigen-antibody reaction, of the non-A, non-B hepatitis virus particle according to claim 1 or 2.
15. A vaccine for non-A, non-B hepatitis, comprising an effective immunogenic amount of a non-A, non-B hepatitis virus particle according to claim 1 or 2, and at least one pharmaceutically acceptable carrier, diluent or excipient.
16. Escherichia coli strain BK102 carrying a non-A, non-B hepatitis virus genomic cDNA, deposited at Fermentation Research Institute, Japan under the accession number FERM BP-3384.
17. Escherichia coli strain BK106 carrying a non-A, non-B hepatitis virus genomic cDNA, deposited at Fermentation Research Institute, Japan under the accession number FERM BP-3385.
18. Escherichia coli strain BK112 carrying a non-A, non-B hepatitis virus genomic cDNA, deposited at Fermentation Research Institute, Japan under the accession number FERM BP-3386.
19. Escherichia coli strain BK146 carrying a non-A, non-B hepatitis virus genomic cDNA, deposited at Fermentation Research Institute, Japan under the accession number FERM BP-3387.
20. Escherichia coli strain BK147 carrying a non-A, non-B hepatitis virus genomic cDNA, deposited at Fermentation Research Institute, Japan under the accession number FERM BP-3388.
21. Escherichia coli strain BK157 carrying a non-A, non-B hepatitis virus genomic cDNA, deposited at Fermentation Research Institute, Japan under the accession number FERM BP-3243.

FIG. 1(1)

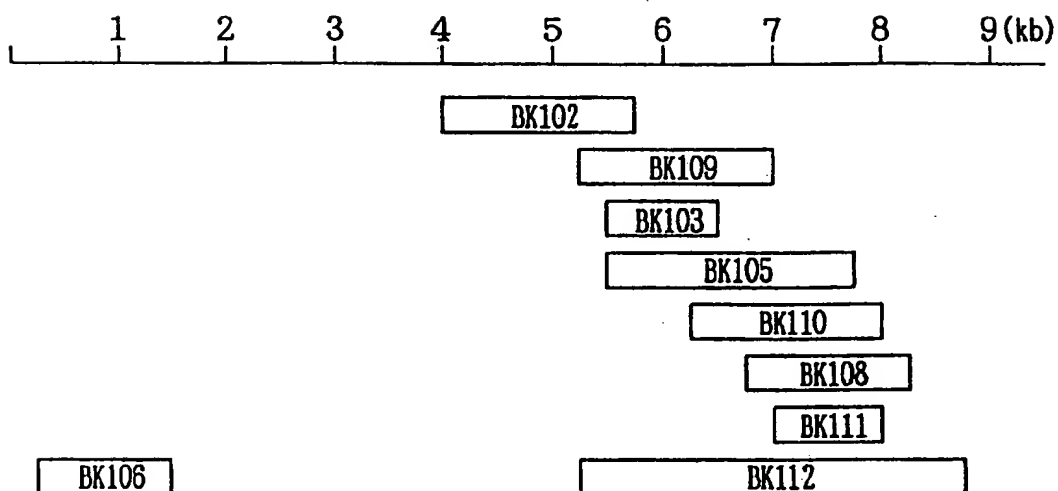


FIG. 1(2)

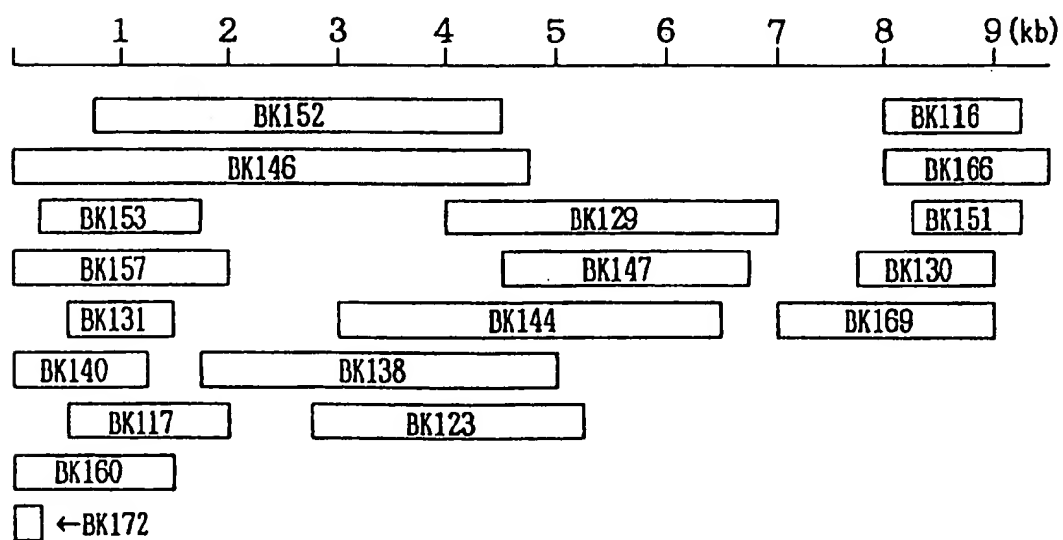


FIG. 2(1)

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1  CGATTGGGGGACACTCCACCATAGATCACTCCCCTGTGAGGAACACTACTGTCTTCAOCGAGAAAGCGTCTAGCCATGGCGTTAGTATGAGTGTCTGTGCAGCCTCCAGGACCCCCCTCC
GCTAACCCCGCGTGTGAGGTGCTATCTAGTAGGGGACACTCCTTGATGACAGAGTGGTCTTTTGGCAGATGGGTACCGCAATCATCTCACAGCAOCTGGAGGTCTCTGGGGGGAGG

121  CCGGAGAGCCATAGTGTCTGGGAACCGGTGAGTACACCGGAATTGCCAGGAGCACCGGTCTCTTTCTTGGATCAACCGCTCAATGCTGGAGATTGGGGGTGCCCCCGGAGACTG
GCCCTCTCGGTATCACCAAGCGCTTGGCCACTCATGTGGCCTTAAGGTCTCTGCGCCAGGAAGAACCTAGTTGGCGAGTTACGGACCTCTAAACCGCACCGGGGGCGCTCTGAC

MetSerThrAsnProLysProGlnArgLys
241  CTAGCCAGTACTGTTGGGTCCGAAAGGCCTTGTGTACTGCTGATAGGTGCTTGGAGTGCCTCCCGGAGGTCTCGTAGCCGTGCACCATGAGCAGCAATCCTAAACCTCAAGAA
GATGGGCTCATCAACCCAGCGCTTTCGGAAACACCATGACGACTATCCCAAGAACGCTCACGGGGGCTCTCCAGAGCATCTGGCAGGTGGTACTGTGCTTAGGATTGGAGTTCTT

ThrLysArgAsnThrAsnArgArgProGlnAspValLysPheProGlyGlyGlnIleValGlyGlyValTyrLeuLeuProArgArgGlyProArgLeuGlyValArgAlaProArg
361  AAACCAAAOGTAAACCAACCGCGCCACAGGAOGTCAAGTTCCCGGGGGGTGGTCAAGATCGTTGGTGGAGTTTACCTGTTGGCGCGAGGGGCCCCAGGTTGGGTGTGGCGGCCCA
TTTGGTTTGCAATTGTGGTTGGGGGGGGTGTCTGTGCAAGTTCAAGGGCGCGCACCAAGTCTAGCAACCAOCTCAAAATGGACAAOCCGCGTCCCCCGGGGTCCAAACCCACAGCGCGCGGGT

LysThrSerGluArgSerGlnProArgGlyArgArgGlnProIleProLysAlaArgArgProGluGlyArgThrTrpAlaGlnProGlyTyrProTrpProLeuTyrGlyAsnGluGly
481  GGAAGACTTCCGAGCGGTGCAACCTGTGGAAGGCGACAACCTATCCCCAAGGCTCCCGGGCCCGAGGCGAGCACTGGGCTCAGCCCGGGTACCCCTGGCCCTCTCTATGGCAATGAGG
CCTTCTGAAGGCTCGCCAGCTTGGAGCACCTTCCGCTGTGGATAGGGGTTCCGAGCGCGGGGTCCCGTCTGTGAAOCCGAGTGGGGCCCATGGGAACCGGAGAGATACCGTTACTCC

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[illegible]

1801	ProProGlnCysThrIleValProAlaSerGluValCysGlyProValITyrCysPheThrProSerProValIValIValGlyThrThrAspArgPheGlyValIProThrTyrArgTrpGly CACTCCACAATGTACCATCCTACCTGCGTCCGGAGGTGTGGGCCCCAGTCTACTGCTTCACCCCAAGCCCTGTGCTGTGGGACGACGATCGTTTCCGTCCCTACGTATAGATGGG GTGGAGGTGTTACATGTTAGCATGGACGCGCCTCCACACGCGCGGTTCACATGAACGAGTGGGGTTCGGGACAGCAGCACCCCTGCTGGCTAGCAAAACGACAGGGATGCAATATCTACCC
1921	GluAsnGluThrAspValIleuLeuLeuAsnAsnThrArgProProGlnGlyAsnTrpPheGlyCysThrTrpMetAsnSerThrGlyPheThrLysThrCysGlyGlyProProCysAsn GGCAGAACGAGACTGCTGCTGCTCAACAACGCGCGCGCGCAAGCACTGTTCCGGCTGCACATGATGATAGCACCGGGTTCACCAAGACATGTGGGGGCCCCCGCTGTGA CCCTCTTCTCTGACTGCACGACGACGAGTTGTTGTGCGCGCGCGGTTCGGTTGACCAAGCGACGTGTACCTACTTATCGTGGCCCCAAGTGGTTCGTGTACACCCCGCGGGGACACAT
2041	IleGlyGlyValGlyAsnAsnThrLeuThrCysProThrAspCysPheArgLysHisProGluAlaThrTyrThrLysCysGlySerGlyProTrpLeuThrProArgCysMetValAsp ACATGGGGGGGTGGCAACACACACCTGACCTGCCCCGAGCTGCTTCCGGAAGCACCCCGAGGCTACCTACACAAATGTGGTTCGGGGCCTTGGCTGTGACACCTAGGTGCATGGTTG TGTAGCCCCCCCAGCGGTTGTTGTGGGACTGGACGGGTGCTGACGAGGGCTTCTGTGGGGCTTCGATGGATGTGTTTACACCAAGCCCCCGAACCAGACTGTGGATCCACGTACCAAC
2161	TyrProTyrArgLeuTrpHisTyrProCysThrValAsnPheThrIlePheLysValArgMetTyrValGlyGlyValGluHisArgLeuAsnAlaAlaCysAsnTrpThrArgGlyGlyGlu ACTATCCATACAGGCTCTGGCATTACCCCTGCACCTGTTAACTTACCATCTTCAAGGTTAGGATGTATGTGGGGGGGTGGAGCACAGGCTCAATGCTGTGATGCAATTTGACCCCGAGGAG TGATAGGTATGTCCGAGACCGTAATGGGGAAGTGACAAATGGTAGAAGTTCCAATCCTACATACACCCCGCCACCTCGTGTCCGAGTTACGACGTAACTGAGCTGCTCCTC
2281	ArgCysAspLeuGluAspArgAspArgProGluLeuSerProLeuLeuSerThrThrGluTrpGlnValIleuProCysSerPheThrThrLeuProAlaLeuSerThrGlyLeuIle AGGTTGTGACTTGGAGGACAGGGATAGGCCGAGCTCAGCCGCTGCTGCTGCTCTACAACAGAGTGGGAGGTACTGCTGCTGTTCTTCAACACCCCTACCACTCTGTCCACTGGCTTGA TCCACAACACTGAACCTCTGTCCTATCCGGCTTCGAGTGGGCGACGACAGATGTTGTCTCACGCTCCATGACGGGACAGGAAGTGGTGGGATGCTGAGACAGGTGACCGCAACT

FIG. 2(5)

HisLeuIleGlnAsnIleValAspValGlnTyrLeuTyrGlyIleGlySerAlaValValSerPheAlaIleLysTrpGluTyrValLeuLeuLeuPheLeuLeuAlaAspAlaArg
 2401 TTCACTCCATCAGAACATCGTGGACGTGCATACCTATACGTATAGGGTCAGGGTTGTCTCCTTTGCAATCAATGGAGTATGTCTGTGCTTTCTCTAGCGGAGGCAC
 AAGTGGAGGTAGTCTGTAGCACCTGCACTTATGGATATGCCATATCCAGTCCCAACAGAGGAACGTTAGTTACCTCATACAGGACACACGAAAGGAAGAGGATCGCCTGGGTG

ValCysAlaCysLeuTrpMetLeuLeuIleAlaGlnAlaLeuGlnAsnLeuValValLeuAsnSerAlaSerValAlaGlyAlaHisGlyIleLeuSerPheLeuVal
 2521 GTGTCTGTGCTGCTGTGGATGATGCTGTGATAGCCACGGCCGAGGCCCTTGGAGAACCTGGTGTCTCAATTGGGCTCTGTGGCGGGCCACATGGGCATCCTCTCCTTCTCTTG
 CACAGACACGGACGACACCTACTACGACGACTATCGGGTCCGGCTCCGGCGGAACCTCTTGGACCAACGAGGAGTTAAGCCGACACACCGCGCGGTGTACCGTAGGAGAGGAAGGAAC

PhePheCysAlaAlaTrpTyrIleLysGlyArgLeuValProGlyAlaThrTyrAlaLeuTyrGlyValTrpProLeuLeuLeuLeuAlaLeuProProArgAlaTyrAlaMet
 2641 TGTTCCTCTGTGCGGCTGGTACATCAAGGACGGCTGGTCCCTGGGGGACACATATGCTCTTTATGGGCTGTGGCTCTCTGCTCTGTGGCATTACCAACCGAGCTTAAGCCCA
 ACAAGACACACGGGACCATGTAGTTCCCTCCACACGGGACCCCGCTGTATACGAGAAATACCGCACACCGGGCAGAGGACGAAACCGTAATGGTGGCGCTCGAATGCGGT

AspArgGluMetAlaAlaSerCysGlyGlyAlaValPheValGlyLeuValLeuLeuThrLeuSerProTyrTyrLysValPheLeuAlaArgLeuIleTrpTrpLeuGlnTyrPheThr
 2761 TGGACCGGGAGATGGCTGCATCGTGGAGGCGGGTTTTGTGGGTCTGGTACTCTGACTTGTGACCATACTACAAGGTGTCTCTGGCTAGGCTCATATGGTGGTTACAATATTTTA
 ACCTGGCCCTCTACCGAGGTAGCAGCGCTCCGGCCCAAAACACCCAGACCATGAGGACTGAAACAGTGGTATGATGTTCCACACAGGAGCGATCCGAGTATACCCACCAATGTTATAAAT

ThrArgAlaGlnAlaAspLeuIleValTrpIleProProLeuAsnAlaArgGlyGlyArgAspAlaIleIleLeuLeuMetCysAlaValHisProGluLeuIlePheAspIleThrLys
 2881 CCACCAAGCCGAGGGGAGCTTACATGTGTGGATCCCCCCTCAAGCTCGGGGAGGCGGGATGCCATCATCTCTCATGTGGGCGAGTCCATCCAGAGCTAATCTTTGACATCACCA
 GGTGGTCTCGGCTCGGCTGGAATGTACACACCTACGGGGGGGAGTTGGAGCCCTCCGGCGCTAAGTAGTAGGAGGAGTACACGCGTCAGGTAGGTCTCGAATAGAACTGTAGTGGT

FIG. 2(6)

LeuLeuIleAlaIleLeuGlyProLcuMetValLeuGlnAlaGlyIleThrArgValProTyrPheValArgAlaGlnGlyLeuIleHisAlaCysMetLeuValArgLysValAlaGly
 3001 AACTTCTAATTGCCATACCTGGTCCGCTCATGGTCTCCAAAGCTGGCATAACAGAGTGCCTACTTCTGCGCGCTCAAGGCTCATTCATGCTGCATGTTAGTGGGAAGGTGGCTG
 TTGAAGATTAAOGGTATGAGCCAGGCGAGTACCAAGAGGTTCCAGCGTATTGGTCTCAGCGCATGAAGCAGCGCGAGTCCCGAGTAAGTAAGTACGAATCAAGCCTTCCAGCGAC

 GlyHisTyrValGlnMetAlaPheMetLysLeuGlyAlaLeuThrGlyThrTyrIleTyrAsnHisLeuThrProLeuArgAspTrpProArgAlaGlyLeuArgAspLeuAlaValAla
 3121 GGGGTCAATTATGTCCAAATGGCTTCATGAAGCTGGGCGGCTGACAGGCAAGTACATTTACAACCATCTTACCCGCTACGGGATTGGCCACGCGCGGCTTACAGACCTTGGCGTGG
 CCCCAGTAATACAGTTTACCGGAAGTACTTCCAGCCGCGACTGTCCGTGCATGTAAATGTTGGTAAATCGGGCGATGCCCTAACCGGTGCGCGCGCGATGCTCTGGAAACGCCACC

 ValGluProValValPheSerAspMetGlnThrLysIleIleThrTrpGlyAlaAspThrAlaAlaCysGlyAspIleIleLeuGlyLeuProValSerAlaArgArgGlyLysGluIle
 3241 CAGTGGAGCCGCTGTCTCTCCAGCATGGAGACCAAGATCATCACCTGGGAGCAGACACCGCGCGTGTGGGACATCATCTTGGGTCTGCCCTCTCCGCGCGAAGGGGAAAGGAGA
 GTCACCTCGGGCAGCAGAGAGGCTGTACCTCTGGTCTAGTATGGACCCCTCTCTGTGGCGCGCACACCCCTCTAGTAGAACCCAGACGCGGCGAGAGGCGGCTTCCCTTCTCTCT

 LeuLeuGlyProAlaAspSerLeuGluGlyArgGlyLeuArgLeuAlaProIleThrAlaTyrSerGlnGlnThrArgGlyLeuLeuGlyCysIleIleThrSerLeuThrGlyArg
 3361 TACTCTGGGCGCGCGATAGTCTTGAAGGCGGGGTTGGACTCCTCGCGCCATCAAGGCTACTCCCAACAGAGCGGGGCTACTTGGTTGCATCATCACTAGCCTTACAGGCC
 ATGAGGACCGGGCGGGCTATCAGAACTTCCCGCCCCCAAGCGCTGAGGAGCGCGGGTAGTGCCTGATGAGGTTCTCTGGCGCGCGATGAACCAAGTAGTAGTATCGGAATGTCCGG

 AspLysAsnGlnValGluGlyGluValGlnValValSerThrAlaThrGlnSerPheLeuAlaThrCysValAsnGlyValCysTrpThrValTyrHisGlyAlaGlySerLysThrLeu
 3481 GGGACAAGAACCAAGTCCAGGAGAGGTTGAGGTGGTTTCCACGCAACACAAATCCTTCTGGGACCTGGCTCAAGGCGTGTGTGGACGTTTACCATGGTGTGGCTCAAGACCT
 CCCTGTTCTTGGTCCAGCTCCCTCTCCAGTCCACCAAGGTGGGTTGTGTTAGGAAGGACCGCTGCAAGTGTGCGCACACAACTGGCAATGCTACCAAGAGTTTCTGGA

FIG. 2(7)

AlaAlaProLysGlyProIleThrGlnMetTyrThrAsnValAspGlnAspLeuValGlyIleProLysProProGlyAlaArgSerLeuThrProCysThrCysGlySerSerAspLeu
 3601 TAGCCGCGCCAAAGGGGCCAATCACCCAGATGTACACTAATGTGGACCCAGGACCTCTCGCTGGCCCAAGCCGCCGGGGCGCTTCCTTGACACCATGCACCTGTGGCAGCTCAGACC
 ATCGGCGCGGTTCCCGCGTTAGTGGTCTACATGTGATTACACCTGGTCTGGAGCAGCCGACCGGGTTCCGGGGCGCCCGCGCAAGCACTGTGGTACGTGGACACCGTCCGAGTCTGG

 TyrLeuValThrArgHisAlaAspValIleProValArgArgGlyAspSerArgGlySerLeuLeuSerProArgProValSerTyrLeuLysGlySerSerGlyGlyProLeuLeu
 3721 TTTACTTGGTCAOGAGACATGCTGACGTCAATTCGGTGCGCGCGGGGCGACAGTAGGGGAGCGCTGCTCTCCGCCAGGCCCTCTCTACTTGAGGGGCTTTCCGGTGGTCCACTGC
 AAATGAACCCAGTGTCTGTACGACTGCAGTAGGCCCAOGCGCGCGCCCGCTGTCTATCCCGCTCGEACGAGAGGGGGTCCGGACAGAGGATGAACCTTCCCGAGAGGCCACCCAGGTGACG

 CysProPheGlyHisAlaValGlyIlePheArgAlaAlaValCysThrArgGlyValAlaLysAlaValAspPheValProValGluSerMetGluThrThrMetArgSerProValPhe
 3841 TCTGCCCTTCCGGCAOGCTGTGGGCATCTTCCGGCTGCCATATGCACCCCGGGGGTTCGCAAGCGGGTGGACTTTGTGCCCGTAGAGTCCATGGAAACTACTATGCGGTCTCCGGTCT
 AGACGGGGAAGCCCGTGACACCCCGTAGAGGCCCGAOGGCATACGTGGGCGCCCAACGCTTCCGCCACTGAACACCGGGCATCTCAGTACCTTTGATGATACGCCAGAGGCCAGA

 ThrAspAsnSerSerProProAlaValProGlnSerPheGlnValAlaHisLeuHisAlaProThrGlySerGlyLysSerThrLysValProAlaAlaTyrAlaAlaGlnGlyTyrLys
 3961 TCAOGBACAACTCATCCCCCGCGCGGTACGCGAGTCAATTCAGGTGGCCCACTACACGCTCCCACTGGCAGCGGCAAGAGTACTAAGTCCGCGTGCATATGCAGCCCAAGGTTACA
 AGTGCCTGTTGAGTAGGGGGGGCGCGCATGGGCTCAGTAAAGTTACCGGGTGGATGTGCGAGGGTGACCGTCCCGTCTCATGATTTACGCGCGCAOGTATACGTCCGGTTCCTCATGT

 ValLeuValLeuAsnProSerValAlaAlaThrLeuGlyPheGlyValaTyrMetSerLysAlaHisGlyIleAspProAsnIleArgThrGlyValArgThrIleThrThrGlyAlaPro
 4081 AGGTGCTCGTCTCAATCCGTCCGTTGGCGCTACCTTAGGGTTTGGGGGTATATGTCTAAGGCACACGCTATTGACCCCAACATCAGAACCTGGGGTAAGGACCATTACCACAGGCGCCC
 TCCACGAGCAGGAGTTAGCGAGGCAOOGGATGGAATCCCAACCCCGCATATACAGATTCCGTGTGGCATAACTGGGGTTGTAGTCTTGACCCCATTCCTGGTAATGGTGTCCGCGGG

FIG. 2(8)

ValThrTyrSerThrTyrGlyLysPheLeuAlaAspGlyGlyCysSerGlyAlaTyrAspIleIleCysAspGluCysIleSerThrAspSerThrThrIleLeuGlyIleGly
 4201 CCGTCACATACTCTACCTATGGCAAGTTTCTTGCAGATGGTGGTCTCTGGGGCGCTTATGACATCATATATGTGATGAGTGCATTCACTGACTCGACTACAATCTTGGGCATCG
 CGCAGTCTATCAGATGGTACCGTTCAWGAAGCGCTACCAACCAAGAGACCCCGCGAATACTGTAGTATTATACACTACTCAOGETAAGTTGACTGAGCTGATGTAGAACCCGTAGC

 ThrValLeuAspGlnAlaGluThrAlaGlyAlaArgLeuValValLeuAlaThrAlaThrProProGlySerValThrValProHisProAsnIleGluGluValAlaLeuSerAsnThr
 4321 GCACAGTCTGGACCAAGCGAGACGGCTGGAGCGGGCTTGTGTGTCTGCCACCGCTACGCCCTCCGGATCGGTCAOCTGCCCCACACCCCAACATCGAGGAGGTGGCCCTGTCTAATA
 CTTGTCAAGACCTGGTTCCCTCTGCGACCTCGCGCGAAACAGCAAGCGCGGTGGCGATGCGAGGCCCTAGCCAGTGGCAGCGTCTGGTTTCTAGCTCTCCACCGGGACAGATTAT

 GlyGluIleProPheTyrGlyLysAlaIleProIleGluAlaIleArgGlyGlyArgHisLeuIlePheCysHisSerLysLysCysAspGluLeuAlaAlaLysLeuSerGlyLeu
 4441 CTGGAGAGATCCCTTCTATGGCAAGCCATCCCCATTGAAGCCATCAGGGGGGAAGGCATCTCATTTTCTGTCAATCCAAAGAAGTGGGAGCGAGCTGCGCAAAAGCTGTCAAGGCC
 GACCTCTCTAGGGGAAGATACCGTTTGGTAGGGTAACCTGGTAGTCCCGCCCTTCCTAGAGTAAAGACAGTAAGTTTCTTTCADCTGCTCGAGCGGCTTTCACAGTCCG

 GlyIleAsnAlaValAlaTyrTyrArgGlyLeuAspValSerValIleProThrIleGlyAspValValValValAlaThrAspAlaLeuMetThrGlyTyrThrGlyAspPheAspSer
 4561 TCGGAATCAAGCTGTGGGTATTACGGGGCTCGATGTGTCCGTCAATCAACACTATCGAGAGCTCGTGTGTGTGGCAACAGAGCGCTCTGATGAGCGGCTATACGGGCGACTTTGACT
 AGCCTTAGTTGCGACACCGCATATGCCCCCGAGCTACACAGGCAGTATGGTTGATAGCTCTGCGAGCAACAGCACCGTTGTCTGCGAGACTACTGCCCGATATGCCCCGCTGAAACTGA

 ValIleAspCysAsnThrCysValThrGlnThrValAspPheSerLeuAspProThrPheThrIleGluThrThrValProGlnAspAlaValSerArgSerGlnArgArgGlyArg
 4681 CAGTGTGACTGTAAACACATGTGTCAACCGACAGTGTGACTTCAGCTTGGATCCACCTTCACCATTTGAGAGCGAAGACCGTGCCTCAAGAGCGAGTGTGCGCTCGCAGCGGGGGTGA
 GTCACTAGCTGACATTGTGTACACAGTGGGTCTGTGAGCTGAAGTCAACCTAGGGTGAAGTGTAACTCTGTGTGTGGCAGCGAGTTCTGTGTGTCACAGCGAGGTGTGCGCGGCCCAT

FIG. 2(9)

4801 ThrGlyArgGlyArgGlyIleTyrArgPheValThrProGlyGluArgProSerGlyMetPheAspSerSerValLeuCysGluCysTyrAspAlaGlyCysAlaTrpTyrGluLeu
 GGA CTGGCAGGGGTAGGAGGCATCTACAGGTTTGTGACTCCGGGAGAAOCCCTCGGGCATGTTGATTCTCTGGTCTGTGTGAGTGTCTATGAGGCGGGCTGTGCTTGGTACGAGC
 CTTGACCGTCCCATCCTCTCTCTAGATGTCAMACACTGAGGCCCTCTTGCCGGAGCCCTACAGCTAAGAGCTAAGAGCACACACTCAGATCTGCGCCCGACAGAACCATGCTCG

4921 ThrProAlaGluThrSerValArgLeuArgAlaTyrLeuAsnThrProGlyLeuProValCysGlnAspHisLeuGluPheTrpGluSerValPheThrGlyLeuThrHisIleAspAla
 TCACCCCGCCAGACCTGGTTAGGTTGGGGCTTACCTGACACACACAGGGTTGCCGTTTGGCAGGACCACTGGAGTTCTGGGAGAGTGTCTTTCACAGGCCCTCACCCATATAGATG
 AGTGGGGCCGGCTCTGGAGCCATCCAAOCCCGGATGACTTGTGTGTCCTCCAAOCCGGCAAOCCGTCTGTGGTGGACCTCAAGACCCCTCTCACAGAAAGTGTCCGGAGTGGGTATATCTAC

76

5041 HisPheLeuSerGlnThrLysGlnAlaGlyAspAsnPheProTyrLeuValAlaTyrGlnAlaThrValCysAlaArgAlaGlnAlaProProProSerTrpAspGlnMetTrpLysCys
 CACACTTCTTGTCCACAGCAGCAGGAGAGCAACTTCCCCTACCTGGTAGCATACCAAGCCAGGTGTGCGCCAGGGCTCAGGGCTCAGGCCCCACCTCCATCATGGGATCAAAATGTGGAAGT
 GTGTGAGAAACAGGGTCTGGTTGGTCTCTGTGANGGGATGGACCATGTAATGGTCCAGCCGTCACAGCCGTCCCGAGTCCGGGTGGAGTAGTACCCCTAGTTACACCTTCA

5161 LeuIleArgLeuLysProThrLeuHisGlyProThrProLeuLeuTyrArgLeuGlyAlaValGlnAsnGluValThrLeuThrHisProIleThrLysTyrIleMetAlaCysMetSer
 GTCTCATACGGCTGAACCTACGCTGCACGGGCCAACACCCCTTGTCTGTACAGGCTGGAGCCCTCCAGAAATGAGGTCACTCCACCCACCCCATAACCAAATACATCATGGCATGCATGT
 CAGAGTATGCGACTTTGGATGACGTGCGCGGTTGTGGGAACGACATGTCCACCTCGGCAGGTCTTACTCCAGTGGAGTGGGTATGGTTTATGTAGTACCGTACCGTACA

5281 AlaAspLeuGluValValThrSerThrTrpValLeuValGlyGlyValLeuAlaAlaLeuAlaTyrCysLeuThrThrGlySerValIleValGlyArgIleIleLeuSerGly
 CCGCTGACCTGGAGGTCTCACTAGCACCTGGGTGCTGGTGGGGGGAGTCTTGGAGCTCTGGCCCGGATATTGCTGACAAACAGGCAGTGTGGTCAATTGTGGGTAGGATTATCTTGTCCG
 GCGACTGGAACCTCCAGCAGTGATCTTGGACCCACAGACCAOCCCGCTCAGGAAGTCCAGACCGGCGCATAAAGAGTGTGTCCGTCCACACCAAGTAACACCCCATCTTAATAGAACAGGC

FIG. 2(10)

ArgProAlaIleValProAspArgGluLeuLeuTyrGlnGluPheAspGluMetGluGluCysAlaSerHisLeuProTyrIleGluGlnGlyMetGlnLeuAlaGluGlnPheLysGln
 5401 GGAGCCCGCCCATTTGTTCCCGACAGGAGTTCTCTACAGGAGTTCCATGAATGGAGAGTGGCTCGCACCTCCCTTACATCGAGCAGGGAATGCAGCTCGCGAGCAATTCACAGC
 CCTCCGGCGGTACAAGGGTGTCCCTCGAAGAGATGGTCTCAAGCTACTTTACCTTCTCACGGGAGCGGTGGAGGAATGTAGCTCGTCCCTTACGTCCAGCGGCTCGTTAAGTTCCG

LysAlaLeuGlyLeuLeuGlnThrAlaThrLysGlnAlaGluAlaAlaProValValGluSerLysTrpArgAlaLeuGluThrPheTrpAlaLysHisMetTrpAsnPheIleSer
 5521 AGAAGCGCTCGGGTTACTGCCAAACAGCCACCAACAAGCGGAGGTGCTGCTCCCGTGGTGGAGTCCAAAGTGGCGAGCCCTTGAGACATTTCTGGGGAAGCACATGTGTGGAATTTTCATCA
 TCTTTGGGAGGCCCAATGACGTTTGTGGTGGTTTGTGGCTCCGAGACGAGGGCACCACCTCAGGTTCAACCGCTCGGGAACCTCTGTAAAGACCCCGCTTCTGTACACCTTAAAGTAGT

GlyIleGlnTyrLeuAlaGlyLeuSerThrLeuProGlyAsnProAlaIleAlaSerLeuMetAlaPheThrAlaSerIleThrSerProLeuThrThrGlnSerThrLeuLeuPheAsn
 5641 GCGGGATACAGTACTTAGCAGGCTTATCCACTCTGCTGGGAACCCCGCAATAGCATATTGATGGCATTCACAGCTCTATCACCAGCCCGCTCACACCACCAAGTACCCCTCCTGTTTA
 CGCCCTATGTATCATGAATCGTCCGAAATAGGTGAGACGACCCCTTGGGGCGTTATCGTAGTAACCTACCGTAAGTGTCCAGATAGTGTCCGGCGAGTGGTGGGTTTCATGGGAGGACAAAT

IleLeuGlyGlyTrpValAlaAlaGlnLeuAlaProProSerAlaAlaSerAlaPheValGlyAlaGlyIleAlaGlyAlaValGlySerIleGlyLeuGlyLysValLeuValAsp
 5761 ACATCTTGGGGGGTGGTGGCTGCCCAACTCGCCCGCCCGCAGCGCGCTTGGGCGCGCGCATCGCGGTGGCGGTGGTGGCAGCATAGCGCTTGGGAAGGTGCTTGTGG
 TGTAGAACCCCGCCACCCACCGGTTGAGCGGGGGGTGCGCGAAGCCGAAAGCACCGCGCGCTAGCGGCCAGCGCGACACCGTGTATCGGAACCGCTTCCACGAAACACC

IleLeuAlaGlyTyrGlyValAlaGlyAlaLeuValAlaPheLysValMetSerGlyGluMetProSerThrGluAspLeuValAsnLeuLeuProAlaIleLeuSerProGly
 5881 ACATCTGGCGGGTTATGGAGCAGGAGTGGCGCGCTGTTGGCTTTAAGGTCAATGAGCGGCGAGATGCCCTCCACGAGGACCTGGTCAATCTACTTCTGCGCATCTCTCTCCTG
 TGTAGACGCGCCCAATACCTGCTCACCGCGCGCGAGCACCGGAAATTCAGTACTCTGCGCTCTAGGGAGGTGGCTCTGGACCATTTAGATGAAGGACGCGTAGGAGAGAGGAC

[illegible]

FIG. 2(12)

ValGluValIThrArgValGlyAspPheHisTyrValThrGlyMetThrThrAspAsnValLysCysProCysGlnValProAlaProGluPhePheSerGluValAspGlyValArgLeu
 6601 AOSTGGAGGTCACTGGGGGATTTCCACTACGTACGGGCATGACCACTGACAAAGTAAAGTGCCTATGCCAGGTTCCGGCTCCTCAATTCTTCTCGGAGGTGGAOAGGAGTGGGT
 TGCACCTCCAGTGGCCCAACCCCTAAAGGTGATGCATGCGGTACTGTGACTGTTCAGGGCTACGGTCCAAAGGCCAGGACTTAAGAAGAGCCTCCACCTGGCTCAOCCCA

 HisArgTyrAlaProAlaCysArgProLeuLeuArgGluGluValIThrPheGlnValGlyLeuAsnGlnTyrLeuValGlySerGlnLeuProCysGluProGluProAspValAlaVal
 6721 TGCACAGGTACGCTCGGGGTGCAGGCCTCTCCTACGGGAGGAGTTACATTCCAGGTGGGCTCAACCAATACCTGGTTGGTCCACAGCTACCATGGAGCCGAAACCGGATGTAGCAG
 ACGTGTCCATGGAGGCCCAOCTCGGAGAGGATGCCCTCCTCCAATGTAAAGTCCAGCCCGAGTTGGTTAAGGACCAACCACTGTCTATGTTACGCTCGGGCTTGGGCTACATCGTC

 LeuThrSerMetLeuThrAspProSerHisIleThrAlaGluThrAlaLysArgArgLeuAlaArgGlySerProProSerLeuAlaSerSerAlaSerGlnLeuSerAlaProSer
 6841 TGCTCACTTCCATGCTCACGACCCCTCCACATCACAGCAGAAACGGCTAAGCGTAGGTTGGCCAGGGGCTCTCCCTCTTGGCCAGCTCTTCAGTAGCCAGTTGTCTGGGCTT
 ACGACTGAAGGTACGAGTGGCTGGGGAGGGTGTAGTGTCTCTTTGCCGATTGSCATCCAAACCGGTCGCCAGAGGGGGAGGAACCGGTGAGAAAGTGTGATGGTCAACAGACGCGGAA

 LeuLysAlaThrCysThrThrHisHisValSerProAspAlaAspLeuIleGluAlaAsnLeuLeuTrpArgGlnGluMetGlyValAsnIleThrArgValGluSerGluAsnLysVal
 6961 CTTTCAGGCGACATGCATACCCACCATCTCTCTCGGACGCTGACCTCATCGAGGCCAACCTCCTGTGGCAGAGAGATGGCGGGAACATCACCCGCTGGAGTCCGAGAACCAAGG
 GGAACTTCGCTGTACGTGATGGTGGTACAGAGAGGCCTGCGACTGGAGTACCTCGGTCAGGACACCCGCGCTCTCTACCCGCGCTTGTAGTGGGCGSCACCTCAGGCTCTTGTGTTCC

 ValValLeuAspSerPheAspProLeuArgAlaGluGluAspGluArgGluValSerValProAlaGluIleLeuArgLysSerLysLysPheProAlaAlaMetProIleTrpAlaArg
 7081 TGGTAGTCTGGACTCTTTGACCCGCTTTCAGCGGAGGAGGATGAGAGGGAAGTATCGTTCCGGCGGAGATCTTGGGAAATCCAAAGAGTTCCCGCGCAGCGATGCCCATCTGGGCGC
 ACCATCAGGACCTGAGAAAGCTGGGGGAGGCTCGCTCTCTACTCTCCCTCTACTAGGCAAGCCGCTCTAGGAGCCCTTTAGTGTCTTCAGGGGGGCTTGGTACGGGTAGACCCGCG

FIG. 2(13)

ProAspTyrAsnProProLeuLeuGluSerTrpLysAspProAspTyrValProProValValHisGlyCysProLeuProProIleLysAlaProProIleProProArgArgLys
 7201 GCGCGATTACAACTCCACCTCCACTGTTAGAGTCTCTGGAGGACCGGACTAGTCCCTCCGTGGTGTCACGCGTGCCCTTGCCACCTATCAGGCCCTCCAAATACCACCTCCACGGAGAA
 CCGGCTAATGTTGGAGGTGACAATCTCAGGACCTTCTGGGCTGATGCGAGGAGGCCACCAAGTGCACGCGCAACGCTGGATAGTTCCGCGGAGGTTATGTTGGAGGTGCCTCTT

ArgThrValValLeuThrGluSerSerValSerSerAlaLeuAlaGluLeuAlaThrLysThrPheGlySerSerAlaValAspSerGlyThrAlaThrAlaLeuProAsp
 7321 AGAGGACGGTTGCTTACAGAGTCTCTCGTGTCTTCTGCTTACGCGAGTCTGCTACTAAGACCTTCCGACGCTCCGAAATCATCGGCCCTGACAGCGCACCGCGCCCTTCCCTG
 TCTCCTGCCAACAGGATTGCTCAGGAGGCACAGAGAGGATCCCTCCAGGCGATGATTCTGGAAGCGCTCCAGGCTTAGTAGCGCGCAGCTGTGCGCTGCCGCTGGCGGAGGAC

GluAlaSerAspAspGlyAspLysGlySerAspValGluSerTyrSerSerHetProProLeuGluGlyGluProGlyAspProAspLeuSerAspGlySerTrpSerThrValSerGlu
 7441 ACCAGGCTCCGACGACGGTGACAAAGGATCCGACGTTGAGTCTCTCCATGCCCCCTTGAGGGGGAACCGGGGACCCCGATCTCAGTGACGGTCTTGCTTACCGTGAGCG
 TGGTCCGAGGCTGCTGCCACTGTTCTAGGCTGCAACTCAGCATGAGGAGGTACGGGGGAACTCCCGCTTGGCCCTGCGGCTAGAGTCACTGCCAGAACCAAGATGGCACTGCG

GluAlaSerGluAspValValCysCysSerMetSerTyrThrTrpThrGlyAlaLeuIleThrProCysAlaAlaGluGluSerLysLeuProIleAsnAlaLeuSerAsnSerLeuLeu
 7561 AGGAAGCTAGTGAGGATGCTCTGCTGCTCAATGTCCTACACATGGACAGGCGCTTGATCAGCCATGCGGTGCGAGGAAGCAAGCTGCCCATCAAGCGCTTGAGCAACTCTTTGCG
 TCCTTCGATCACTCTACAGCAGAGCAGAGTTACAGGATGTGTACCTGTCCGCGGAACTAGTGCGGTACGCGCTCCCTTCTGTTCCAGGGTAGTTGGCGCAACTCGTTGAGAAACG

ArgHisHisAsnMetValTyrAlaThrThrSerArgSerAlaGlyLeuArgGluLysLysValThrPheAspArgLeuGluValLeuAspAspHisTyrArgAspValLeuLysGluMet
 7681 TGCGCCACCATAAATGGTTTATGCCACAACATCTCCAGCGCAGGCTCGCGCAGAGAGGTCACCTTTGACAGACTGCAAGTCTCTGGACGACCACTACCGGGAAGTCTCAAGGAGA
 ACGGCTGGTATTGTACCAATACGGTGTGTGTACAGGCTCGGACGCGCTCTTCTTCCAGTGGAAAACTGTCTGACGTTCAGAACCTGCTGCTGATGGCCCTGGCAGAGTTCCTCT

FIG. 2(14)

LysAlaLysAlaSerThrValLysAlaLysLeuLeuSerValGluGluLysLeuThrProProHisSerAlaLysSerLysPheGlyTyrGlyAlaLysAspValArgAsnLeu
 7001 TGAAGGCGAAGGCGTCCACAGTTAAGGCTAAACTCTATCGTAGAGGAAGCTGCAAGCTCAAGCCCAATCCCAAGTTGGCTATGGGGCAAGGACGTCGGGAACC
 ACTTCGGCTTCGGCAGGTGTCAATTCCGATTTGAGGATAGGCATCTCCTTCGGACGTTGACCTGGGGTGTAGCGGTTAGGTTCAACCGATACCCCGTTTCTGACAGGCTTGG

 SerSerLysAlaValAsnHisIleHisSerValTrpLysAspLeuLeuAspThrValIleAspThrThrIleMetAlaLysAsnGluValIlePheCysValGlnProGluLys
 7021 TATCCAGCAAGGCGTTAACACATCCACTCGTGTGGAGGACTTGTGGAGACACTGTGCACCAATTCACACCACTCATGGGCAAAAATGAGTTTCTGTGTCCAAACCCAGAGA
 ATAGTCTGTTCCGGCAATTGGTGTAGGTGAGGCACACCTTCCTGAAGACCTTCCTGTGACACTGTGTTAACTGTGGTGTAGTACCGTTTCTCCAAAAGACACAGGTTGGTCTCT

 GlyGlyArgLysProAlaArgLeuIleValPheProAspLeuGlyValArgValCysGluLysMetAlaLeuTyrAspValIleSerThrLeuProGlnValIleMetGlySerSerTyr
 8041 AAGGAGGCGCTAAGCCAGCCCGCTTATCGTATTCAGATCTGGAGTCCGTGTATGAGAGAGATGGCCCTCTATGATGTGGTCTCCACCCCTTCTCAGGTCGTGATGGGCTCCTCAT
 TTCTCCGGCATTCGGTCGGGCGCAATAGCATAAGGCTCTAGACCTCAGGCACATACGCTCTCTACCGGGAGATACACACAGAGTGGGAAGGAGTCCAGCACTACCCGAGGAGTA

 GlyPheGlnTyrSerProGlyGlnArgValGluPheLeuValAsnThrTrpLysSerLysAsnProMetGlyPheSerTyrAspThrArgCysPheAspSerThrValIleThrGluAsn
 8161 ACGGATTCAGTACTCTCCTGGCAGCGAGTCCAGTTCTGTGTGAATACCTGGAAATCAAGAAAAACCCCATGGGCTTTTCATATGACACTCGCTGTTTCGACTCAACGCTCACCGAGA
 TGCCTAAGGTCATGAGAGGACCCGTCGCTCAGCTCAAGGACCACTTATGGACCTTATGTTTCTTTTGGGGTACCGGAAAAGTATACTGTGAGCGACAAAGCTGAGTTGCCACGTGGCTCT

 AspIleArgValGluGluSerIleTyrGlnCysCysAspLeuAlaProGluAlaArgGlnAlaIleLysSerLeuThrGluArgLeuTyrIleGlyProLeuThrAsnSerLysGly
 8281 ACGACATCCGTGTGAGGAGTCAATTTACCAATGTTGTGACTTGGCCCCCGAAGCCAGACAGGCCATAAATCGCTCACAGAGCGGCTTATATCGGGGTCTCTGACTAATTCAAAAG
 TGCTGTAGGCACAACTCCTCAGTTAATGTTACACACTGAACCGGGGCTTCGGTCTGTCGGTATTTAGCGAGTGTCTCGCGGAAATATAGCCCCCAGGAGACTGATTAACTTTTC

[illegible]

FIG. 2(16)

PheSerLeuIleSerTyrSerProGlyGluIleAsnArgValAlaSerCysLeuArgLysLeuGlyValProProLeuArgValTrpArgIleHisArgAlaArgSerValArgAlaArgLeu
 9001 CATTTTCACTCCATAGTTACTCTCCAGGTGAGTCATATAGGGTGGCTTCATCCCTCAGGAACTTGGGTACCACTTGGAGTCTGGAGACATCGGCCAGGAGCGTCCGGCTAGGC
 GTAAAGTGAGGTATCAATGAGAGGTCCACTCTAGTTATCCCAACGAGTACGGAGTCCCTTTGMAOCCCATGGTGGGACCGCTCAGACCTCTGTAGCCTGGTCTCTCCAGGGCGGATCCG

LeuSerGlnGlyArgAlaAlaThrCysGlyLysTyrLeuPheAsnTrpAlaValLysThrLysLeuLysLeuThrProIleProAlaAlaSerArgLeuIleSerGlyTrpPhe
 9121 TACTGTCCAGGAGGGAGGGGCCCACTTGTGCCAATACCTCTTCACCTGGGAGTAAACCAAACTTAACTCACTCCATCCGGCTGGGTCCGGTGGACTTGTCCGGCTGGT
 ATGACAGGGTCCCTCCCTCCGGGGGTGACACCGGTTTATGGAGAGTGTGACCGGTCATTTTGGTTTGAAATTGAGTGGGTAGGGCCGACGAGGGCCGACCTGMAACAGGGCGGACCA

ValAlaGlyTyrSerGlyGlyAspAlaIleTyrHisSerLeuSerArgAlaArgProArgTrpPheMetLeuCysLeuLeuSerValGlyValGlyIleTyrLeuLeuProAsnArg
 9241 TCGTTGCTGGTTACAGCGGGGAGACATAATATCACAGCCTGTCTCGTCCCGAACCCGGTGGTTCATGCTGTGCTACTCTACTCTCTGTAGGGGTAGGCATCTACCTGCTCCCAACC
 ACCAACGACCAATGTGGCCCTCTGTATATAGTGTGGACAGACAGCAAGGGCTGGGGCAACCAAGTACGACACGGATGAGGATGMAAGACATCCCAATCCGATCCGATGATGAGAGGGGTGG

GATGAACGGGGAGATMAACACTCCAGGCCAATAGGCCATCCCTTTTTTTTTTT
 9361 CTACTTGGCCCTCTATTATTGTGAGGTCCGGTTATCCGGTATGGGGGMAAATAAATAA

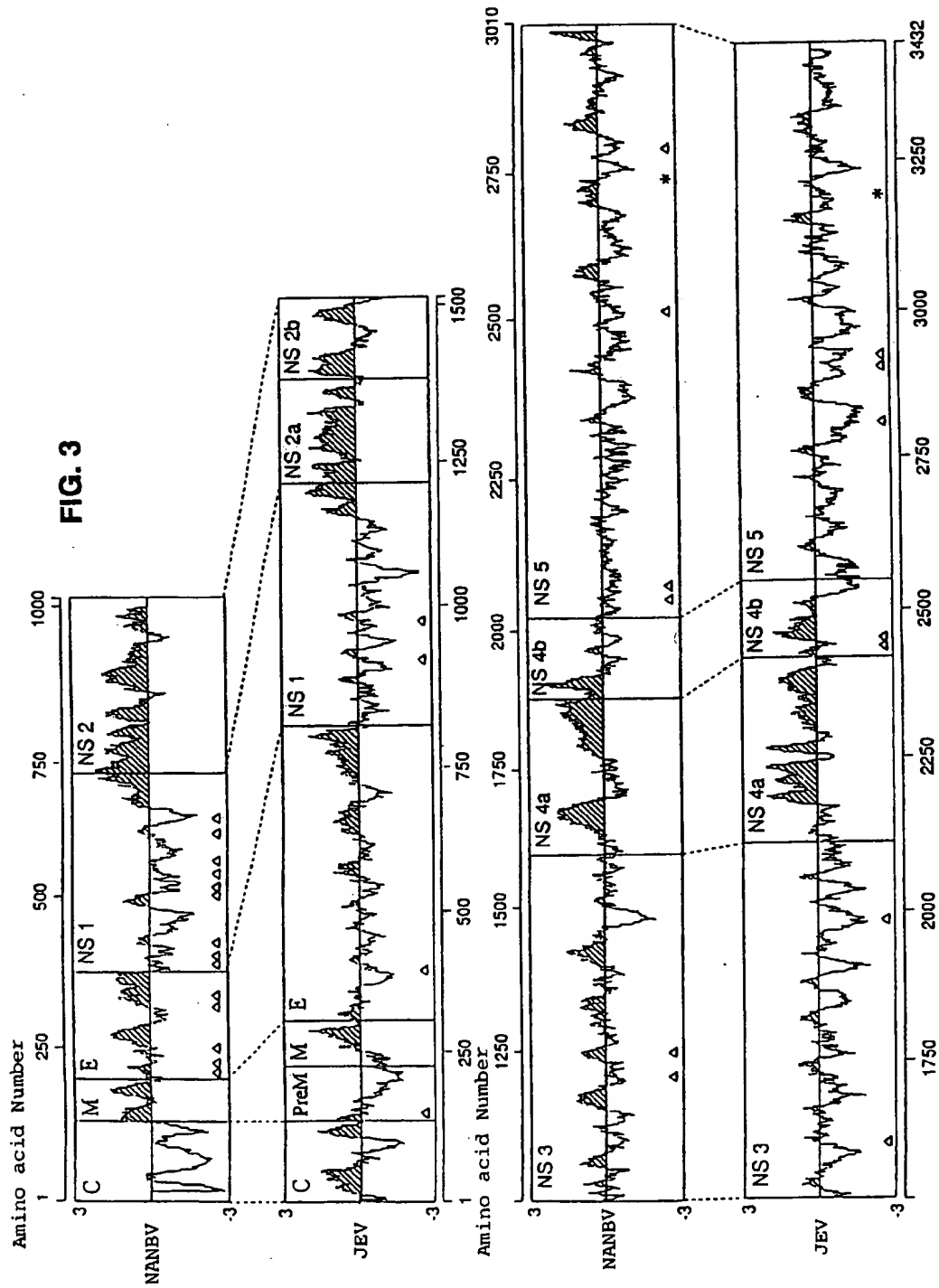


FIG. 4

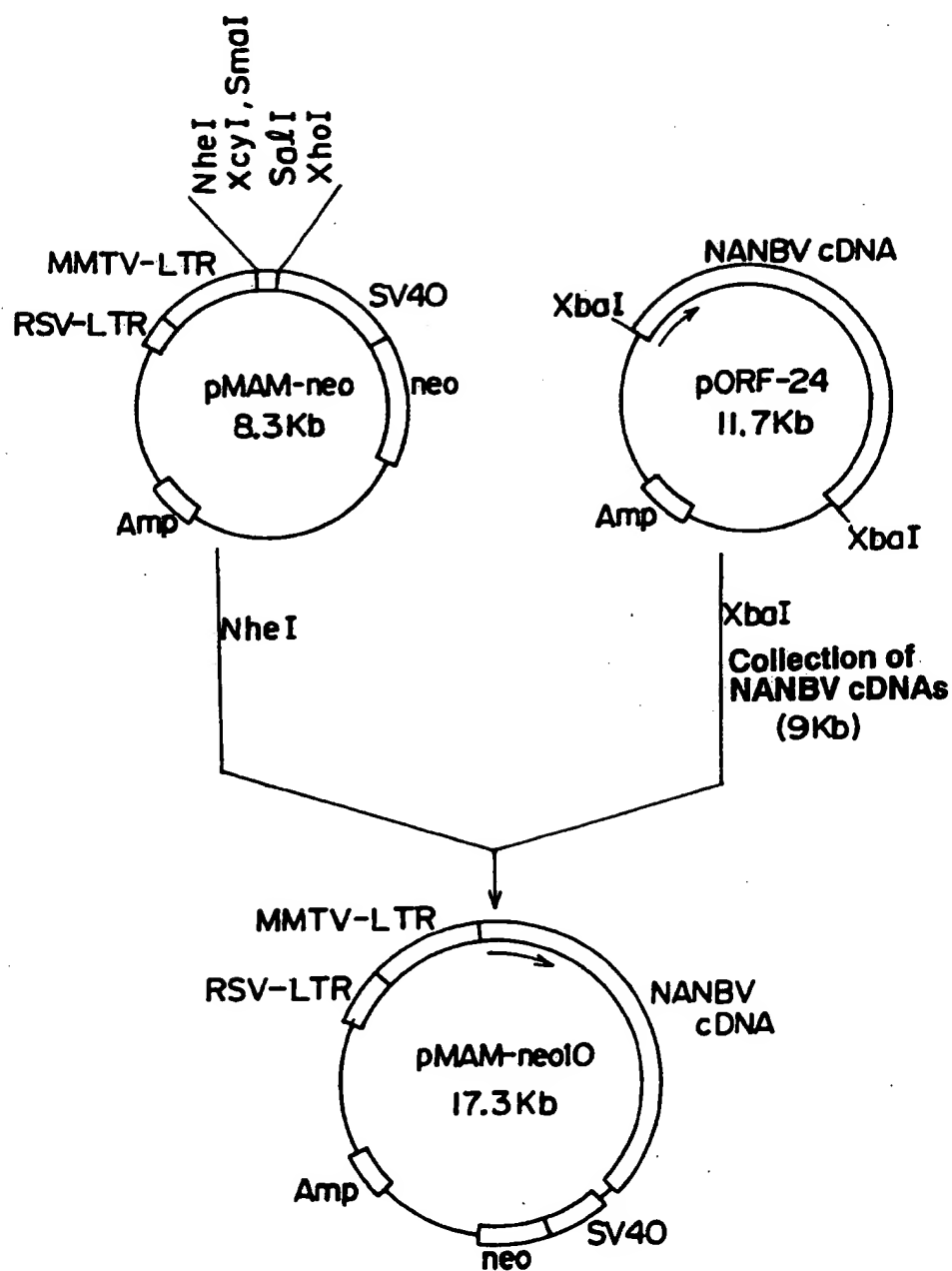


FIG. 5

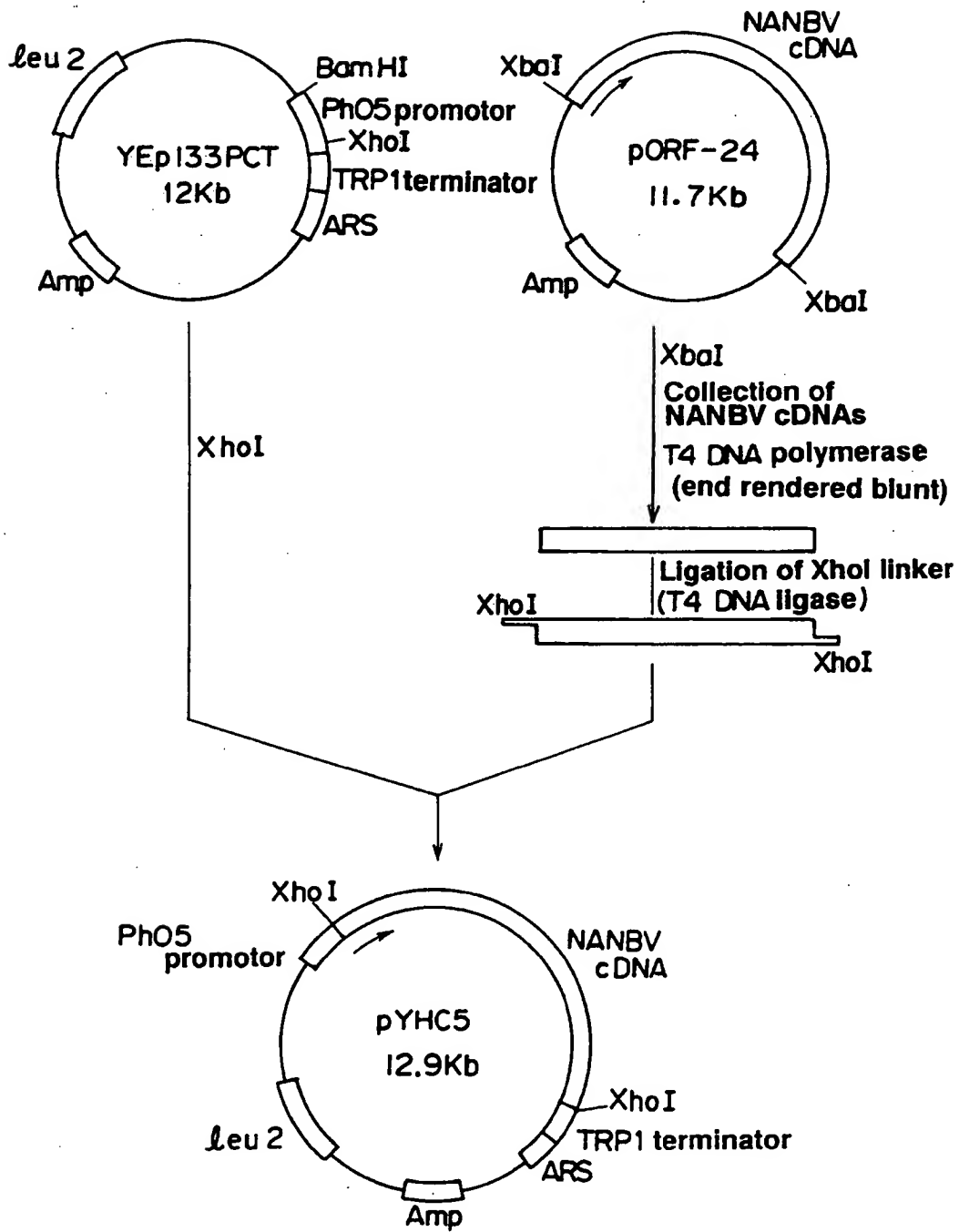


FIG. 6

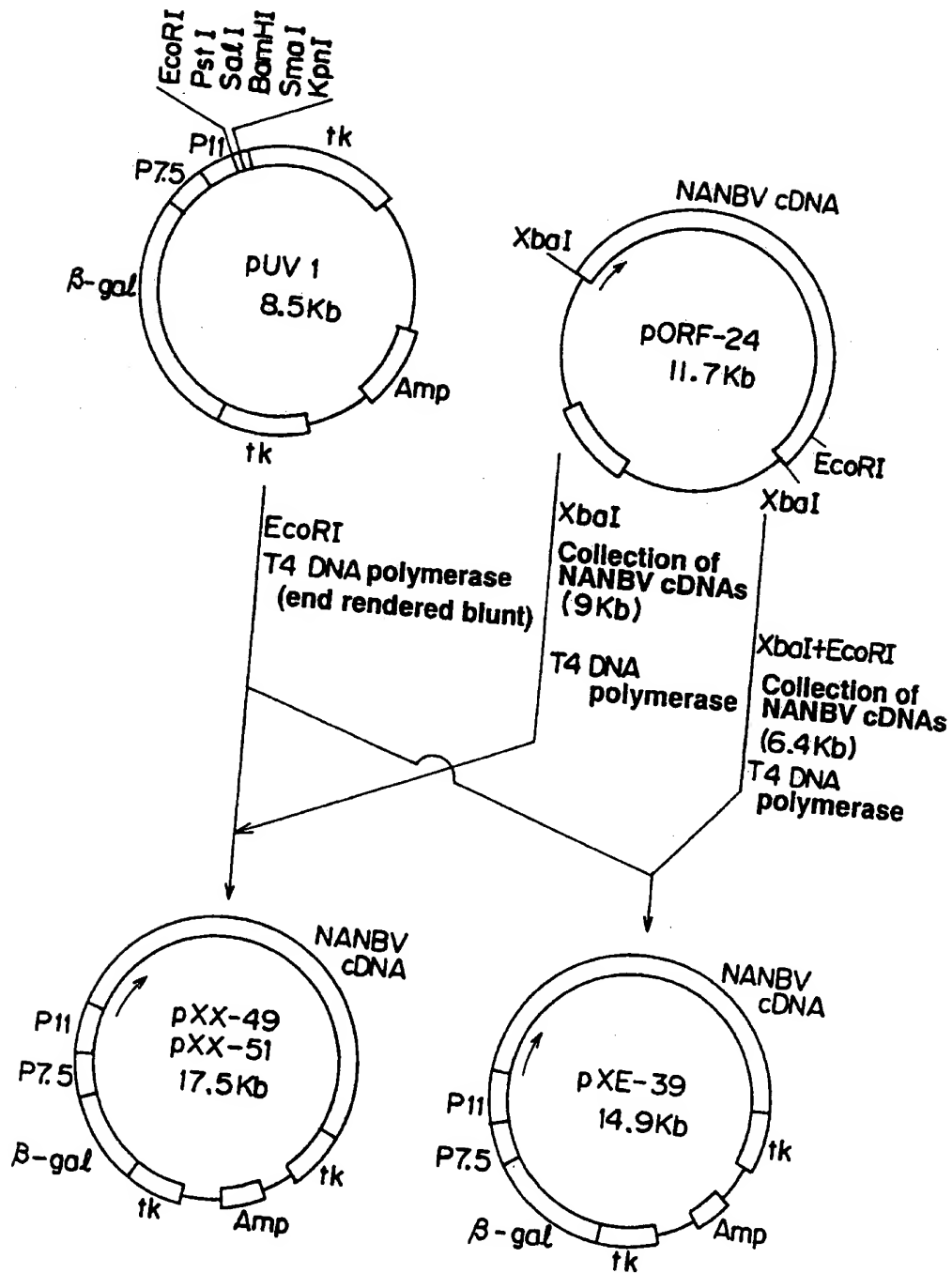


FIG. 7

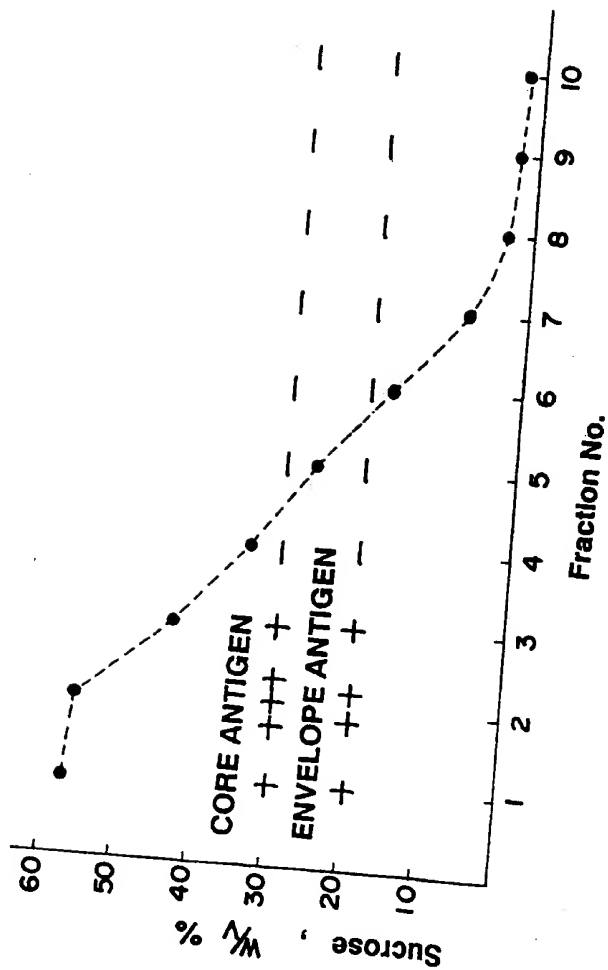


FIG. 8

